Northwest Division, Corps of Engineers
Anadromous Fish Evaluation Program
2006 Research Summaries

Bypass Studies

BPS-P-05-1 Juvenile Salmonid PIT Tag Detection Efficiency Study at Bonneville Dam Corner Collector

BPS-W-04-1 Evaluation of a Prototype Traveling Vertical Barrier Screen at McNary Dam

BPS-W-06-01 Evaluate the Effects of Passage through the McNary Dam Juvenile Bypass Facility and Reservoir on survival for juvenile fall Chinook salmon during summer months.

BPS-W-00-4 Evaluate the Effects of Passage through the Juvenile Bypass Facilities and Reservoirs on Survival of Juvenile Pacific Lamprey.

BPS-00-10 Evaluate Comparative Delayed Mortality of Transported Juvenile Salmon and In-River Migrating Juvenile Salmon.

Spillway and Survival Studies

SPE-P-02-1 Survival of Juvenile Salmonids at Bonneville Dam.

SPE-P-06-NEW Effects of Total Dissolved gas on chum fry

SPE-P-00-8 Juvenile Salmonid Survival Studies at The Dalles Dam

SPE-P-00-7 Juvenile Salmonid Survival Studies at John Day Dam

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SPE-W-04-4 fish passage and survival at Lower Monumental Dam

SPE-W-04-2 Fish passage and survival at Little Goose Dam.

SPE-06-New Establish and Evaluate Specification Criteria for an Active/Passive Migratory Life-Cycle Transmitter

SPE-06-New Effects of Load Following on Reservoir Hydraulics, Juvenile Salmon Migratory Behavior, and Survival

Surface Bypass

SBE-P-00-17 Studies of Surface Flow Bypass at The Dalles Dam.

SBE-W-05-1 Fish passage and survival at Ice Harbor Dam Removable Spillway Weir

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SBE-W-06-NEW Studies of Surface Flow Bypass at McNary Dam.

SBE-P-03-01 Linking Juvenile Salmonid Behavior to Hydraulic Variables

SBE-W-06-01 Evaluate RSW Performance under a range of discharges / High Q

SBE-W-06-02 Evaluation of the effects of vertical temperature gradients on the effectiveness of surface bypass systems at Snake River dams.

Adult Passage Studies

ADS-00-1 Evaluation of Adult Salmon and Steelhead Delay and Ladder Fall Out at Snake and Columbia River Dams.

ADS-00-4 Investigation of Straying in Adult Salmon and Steelhead. (RM&E)

ADS-00-05 Temperature and dissolved gas exposure of adult salmon and steelhead migrants.

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ADS-04-01 White Sturgeon Passage at Lower Columbia River Dams.

ADS-02-16 Evaluation of Marine Mammal Predation below Bonneville Dam

Bull Trout Studies

BT-W-01-1 Effects of the Operations Dworshak Dam and Reservoir on Bull Trout Distribution in the Reservoir and North Fork Clearwater River.

BT-W-06-04 Effects of Water Withdrawal from Dworshak Reservoir on Bull Trout Distribution.

BT-W-05-06 Monitor the use of the main stem Columbia and Snake Rivers by bull trout.

BT-W-05-01 Bull Trout Use of Lower Snake River Reservoirs and the Effects of Operations of Hydroelectric Dams on their Movements.

BT-W-03-01 Investigate the Effects of Water Quality on Bull Trout Survival Near Hydro-projects and Fishways.

Turbine Survival Program

TSP-06-01 Biological Index Testing of Snake and Columbia River Dam Turbines

TSP-05-01 Pressure Acclimation Investigations to Support Biological Index Testing

Avian Studies

AVS-P-05 01 Evaluate Caspian Tern Management Measures Relative to Their Impact on Salmonid Smolts in the Columbia River Estuary

AVS-06-New Evaluate Management Measures and Develop Baseline Information on Double-crested Cormorants Directed at Reducing the Impact of Their Predation on Salmonid Smolts in the Columbia River Estuary

AVS-W-03-1 Evaluate the Impact of Avian Predation on Salmonid Smolts from the Columbia and Snake Rivers

Transportation

TPE-W-New Evaluate the effects of raceway and barge holding practices on SARs of juvenile salmonids collected and transported from Lower Snake River dams

TPE-W-06-02 Alternate Barging Strategies to Improve Survival of Transported Juvenile Salmonids

TPE–W–04–02 Evaluate the effectiveness of transporting Spring/Summer Chinook Salmon and Steelhead at McNary Dam.

TPE–W–04–03 Evaluate the effectiveness of transporting sub-yearling Fall Chinook Salmon at McNary Dam

TPE-W-06-NEW Influence of water characteristics on fish condition of smolts that arrive at Lower Granite Dam

TPE-W-00-06 Analyze the Benefits of Transporting Lower Snake River Juvenile Fall Chinook Salmon

EST-02-01 A Study to Estimate Salmonid Survival Through The Columbia River Estuary Using Acoustic Tags

EST-02-02 Estuarine Habitat And Juvenile Salmon – Current And Historic Linkages In The Lower Columbia River And Estuary

EST-02-03 Evaluation Of The Relationship Among Time Of Ocean Entry, Physical, And Biological Characteristics Of The Estuary And Plum Environment And Adult Return Rates.

EST-02-04 Evaluating Cumulative Ecosystem Response to Habitat Restoration Projects in the Lower Columbia River and Estuary

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: BPS-P-05-1

TITLE: Juvenile Salmonid PIT Tag Detection Efficiency Study at Bonneville Dam Corner Collector

FISH PROGRAM FEATURE: CRFMP:- High flow PIT@B2 corner collector; BPA Project 1983-319-00

UPA MEASURE: RM&E Status Monitoring Substrategy 1.3; Hydrosystem Corridor Monitoring "Continue developing potential improvements to juvenile PIT tag detection systems and alternative technologies associated with high discharge fish passageways (e.g., Bonneville corner collector, spillways and turbines) and tributaries."

MANAGEMENT PURPOSE: Assess performance of a new PIT tag detection system in the Bonneville Corner Collector. The purpose of the new system is to increase PIT tag detection at Bonneville Dam to allow for improvements to system level passage survival monitoring for ESA listed species.

SUMMARY: PIT tag detection at Bonneville Dam is critical to estimating the reach survival of juvenile salmon with a reasonable amount of statistical certainty. The detection efficiency of the existing PIT tag systems at Bonneville Dam has decreased due to the effectiveness of the Corner Collector at passing fish. A new detection system is under development for the Bonneville Corner Collector and is scheduled for installation prior to the 2006 outmigration. A study is needed to assess the performance of the new system.

OBJECTIVES:
1. Estimate detection efficiency of PIT-tagged spring chinook yearling juvenile salmonids passing through the Bonneville Dam Corner Collector with precision levels of ±1, ±3, or ±5%, all at α=0.05 and power of 0.8.
2. Estimate detection efficiency of PIT-tagged steelhead yearling juvenile salmonids passing through the Bonneville Dam Corner Collector with precision levels of ±1, ±3, or ±5%, all at α=0.05 and power of 0.8.
3. Estimate detection efficiency of PIT-tagged fall chinook subyearling juvenile salmonids passing through the Bonneville Dam Corner Collector with precision levels of ±1, ±3, or ±5%, all at α=0.05 and power of 0.8.
4. Estimate detection efficiencies for two additional PIT tag models.

SCHEDULE: 2006

NOTE: Proposals should include recommended methods, test fish source, release strategy, and sample size requirements for performing the study. The number of species and tag types to be evaluated will depend on budget priorities to be determined at a later date. This study will likely be funded by the Bonneville Power Administration under the Northwest Power and Conservation Council's Fish and Wildlife Program, Project 1983-319-00. Proposals will need to be reviewed, prioritized, and coordinated under the Council's process. However, this study will also be coordinated and discussed through the Corps' AFEP process, which covers most project-specific passage research, to ensure thorough regional review of the proposed methods.

CONTACT: Scott Bettin (BPA) 503-230-4573; Dennis Schwartz (Corps) 503-808-4779

Northwestern Division- Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: BPS-W-04-01

TITLE: Evaluation of a Prototype Traveling Vertical Barrier Screen at McNary Dam

FISH PROGRAM FEATURE: BPA Large Cap.- McNary Dam Modernization

UPA MEASURE: ESU Specific Actions – McNary Dam – Powerhouse modernization p.37

MANAGEMENT PURPOSE: Develop improved vertical barrier screen system to reduce impacts to juvenile salmonids passing through the bypass system.

SUMMARY: Periodic high in-river debris loads during the fish passage season can increase injury and descaling rates of juvenile salmonids passing through the juvenile bypass system at McNary Dam (MCN). During these high-debris events, project personnel are forced to shutdown turbine units so that vertical barrier screens can be raised and cleaned. This practice of cleaning screens can cause additional injury to juvenile salmonids and is very labor intensive. In addition, overall powerhouse discharge capacity will likely increase with the pending modernization of the MCN powerhouse and could intensify any effects caused by debris in the juvenile bypass system unless an alternative method of debris handling is developed. Of equal or greater concern is debris that can accumulate on the upstream side of the trash racks. In 2004, a prototype traveling vertical barrier screen was scheduled for evaluation of it's effectiveness in removing debris from the gatewell and maintaining acceptable levels of fish condition at increased turbine unit loading. Elevated levels of descaling and injury were observed at the MCN juvenile fish facility during the test and presumed to be the result of 80 MW operation. As a result, the evaluation was terminated. Coincidentally, during periods that a higher incidence of fish injury was observed, excessive amounts of tumbleweeds had also accumulated on the upstream side of the trashracks. Subsequently, a new traveling vertical barrier screen was designed for higher unit discharge, along with modified extended-length submersible bar-screens designed to operate at higher turbine unit discharges (up to ~80 MW). These modified screens were installed in main unit 4 and are currently under evaluation in 2005. Additional plans to develop alternative gatewell debris handing methods are pending and will be based on the results of the 2005 evaluation. However, an alternative method (other than raking trash) to effectively handle debris in the forebay prior to buildup on the trash racks should be explored. Excessive tumbleweed buildup on the trash racks at MCN could be causing as much or more injury to juvenile salmonids than debris buildup and/or hydraulic conditions present in gatewells.

OBJECTIVES: (*Placeholder pending results of 2005 prototype traveling VBS evaluation)*
1. Determine the condition of PIT-tagged yearling and subyearling Chinook salmon passing through a gatewell equipped with a modified traveling vertical barrier screen under two turbine discharge levels.
2. Determine the condition of PIT-tagged yearling and subyearling Chinook salmon passing through a gatewell equipped with a standard vertical barrier screen under two turbine discharge levels.

SCHEDULE: 2006

CONTACT: Dan Feil, 509 527-7295

Northwestern Division – Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: BPS-W-06-01

TITLE: Evaluate the Effects of Passage through the McNary Dam Juvenile Bypass Facility and Reservoir on survival for juvenile fall Chinook salmon during summer months.

FISH PROGRAM FEATURE: CRFMP – McN Temperature Control.

UPA MEASURE: Hydrosystem actions – Temperature measures p. 42.

MANAGEMENT PURPOSE: Determine if there is a biological benefit if operations and/or structural changes are made in the McNary bypass system that reduces temperature gradients.

SUMMARY: Water surface temperatures in the forebay and gatewells of McNary Dam can reach 26°C in July and August. Although the south shore close to the dam tends to heat up first, the entire river surface up to five miles upstream can reach (26°C) with temperatures persisting until late evening, depending on weather conditions. Analysis of temperature data collected in 2004 showed hot surface temperatures (top 10 meters) tended to set up by early afternoon when there was little wind and air temperatures were high; the difference in temperature from top to bottom (30 meters) was as much as 4°C. On days with less solar heating and strong sustained winds the entire forebay was mixed from top to bottom although peak temperatures were still between 21-24°C.
When turbine units are turned on, surface water is pulled into the gatewells resulting in a temperature differential of up to 5°C between the gatewells and the collection channel. Residence time for fish in the gatewells has ranged between 1-12 hours; with lower residence time correlated to number of fish passing. Mortality rates during summer months at the facility have averaged between 1-5%; with no apparent correlation between high temperatures and direct mortality. Research to address temperature exposure and fish condition was conducted in summer of 2000 and 2001 but there were no definitive patterns that linked high temperature with heat shock proteins. Additional research on heat shock proteins was proposed in 2004 but not funded. Existing literature on fall Chinook salmon cites changes of 2-4° C up to 26°C degrees with little to no mortality; but these studies tested changes over an hour rather than instantaneously which are conditions experienced by fish going through the juvenile bypass system at McNary Dam. Before structural modifications can be designed or tested, a better understanding of fall Chinook approach, migration depth and temperature tolerance is needed to better define an optimal condition for fall Chinook passing the project. The CFD model developed for McNary Dam and forebay will be used to evaluate operational changes and temperature response.

Objectives:

1. Using existing available data, analyze relationships among juvenile (subyearling Chinook) mortality, temperatures, river discharge, and operations for period of record at McNary Dam. (2006-2007)

2. Measure swimming depth of fall Chinook as they migrate downstream from the mouth of the Snake River to McNary Dam to determine temperature habitat selection and acclimation in summer months as fish approach the dam. **Placeholder Pending Results of Objective 1** (2007-outyears)

3. Conduct laboratory experiments that replicate temperature conditions through the bypass system and relate to fish survival. **Placeholder Pending Results of Objective 1** (2007-outyears)
    a. Estimate direct and delayed mortality rates of subyearling Chinook associated with thermal stress.
    b. Determine magnitude and duration of temperature reduction needed to eliminate mortality.

4. Monitor physiological indicators of thermal stress and disease to establish baseline condition. Compare stress response of fish passing through south shore gatewells (units 1,2, 3) compared to north shore gatewells (units 11,12,13) during summer months. Determine if there is delayed mortality of fish passing through these gatewells. **Placeholder Pending Results of Objective 1** (2007-outyears).

SCHEDULE: 2006-outyears pending results of objective 1.

CONTACT: Karen Zelch 509-527-7255

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: BPS-W-00-04

TITLE: Evaluate the Effects of Passage through the Juvenile Bypass Facilities and Reservoirs on Survival of Juvenile Pacific Lamprey.

FISH PROGRAM FEATURE: O&M – juvenile lamprey.

UPA MEASURE: NA

MANAGEMENT PURPOSE: Increase survival of lamprey through McNary Juvenile Bypass System.

SUMMARY: There is significant regional concern regarding lamprey populations in the Columbia Basin. In 1993, the Oregon Department of Fish and Wildlife designated Pacific lamprey at risk of being listed as threatened or endangered. The U.S. Fish and Wildlife Service designated Pacific lamprey as a Category 2 candidate species in 1994. The Northwest Power Planning Council's (NPPC) 1994 Fish and Wildlife Program acknowledged the apparent decline of Pacific lamprey and requested a status report to identify research needs. Columbia River treaty tribes have repeatedly voiced concern about the decline of Pacific lamprey, a culturally important species.

Based on counts of lampreys in the daily samples from smolt monitoring personnel and anecdotal observations of abundance of lamprey ammocoetes in juvenile fish facilities at collector projects on the Lower Snake and Columbia Rivers, lamprey numbers appear to be in decline. Little is known about the effects of passage through juvenile bypass facilities on juvenile Pacific lamprey. In 2002, PIT tagged juvenile lamprey were released into the juvenile bypass system at McNary Dam. Despite high detectability when released at the separator, an unexpectedly low percentage of the collection channel released fish were detected on the PIT detectors at the JBS. Additionally, juvenile Pacific lampreys incidentally collected at juvenile fish facilities may be loaded into barges and transported through the hydrosystem [Is this a bad thing?]. Currently, it is not feasible to separate juvenile lamprey from juvenile salmonids and the effects of transporting on the post release survival of juvenile lamprey is unknown.

OBJECTIVES:

1. Determine the location and cause of unaccounted loss of juvenile lamprey in the bypass system at McNary Dam. (2005-2006).

2. Develop a prototype juvenile lamprey separator that could be installed at collector projects on the lower snake and Columbia River dams. (2006-2010)

    a. Develop a juvenile lamprey separator that separates juvenile lamprey from salmonid fry, subyearling, and yearling juveniles in bypass systems at Snake and Columbia River Dams.

    b. Determine the feasibility of modifying the raceway screens at collector dams that would allow juvenile lamprey to pass and return to the river, while maintaining the current criteria to hold fry, subyearling, and yearling salmonids for transportation.

3. Estimate projects passage distribution and estimate project survival rates, once a radio or acoustic telemetry tag that could be fitted to juvenile Pacific lamprey to determine survival estimates through the hydroelectric system is developed.

SCHEDULE: 2005-2010

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: BPS-00-10

TITLE: Evaluate Comparative Delayed Mortality of Transported Juvenile Salmon and In-River Migrating Juvenile Salmon.

FISH PROGRAM FEATURE: CRFMP – tsys – Delayed Mortality of Juvenile Salmonids

UPA MEASURE: RM&E Substrategy 2.1, p. 93, RM&E Substrategy 3, p.100.

BACKGROUND: Much of the post-hydrosystem mortality has been attributed to different routes of passage at the dams (spill, bypass systems, turbines, surface collection and transportation). This concept has been assumed based on adult return data from the juvenile salmon transportation, multiple bypass, and in-river PIT tag survival studies. Juvenile Chinook transported through the hydrosystem survive at a higher rate compared to in-river migrants. Yet if equal post-system mortality is attributed to both groups of juveniles the transportation release group should be returning at a higher rate. The question concerning differential rates of survival (or delayed mortality) in the ocean environment and how they correlated through time and route of passage has become one of the key unknowns facing future decisions regarding construction of passage systems for fish.

Recently, studies addressing the physiological status and condition of smolts arriving at Bonneville Dam have shown transported fish that are released below Bonneville Dam are smaller than fish that have migrated in-river. The time it takes to transport fish through the hydrosystem (about 36 hours) is significantly reduced compared in-river migrants (4-10 weeks) depending on river flows. In-river migrating fish are growing 5-10 mm between Lower Granite and Bonneville, Dams; however, many of these groups of hatchery and wild smolts are in a negative energy balance prior to arrival at Bonneville Dam. The effects of the negative energy balance, fish size, and timing of entry into salt water may correlated to "D" and lead to reduced performance, fitness, and survival in the estuarine and marine environments.

OBJECTIVES:

1. Investigate potential mechanisms and causes of delayed mortality of salmon and steelhead smolts migrating through and around the Snake and Columbia River hydrosystem.

   a. Determine if the route of passage (spill, turbine, and bypass) through the hydrosystem damages the sensory systems (ear, nose lateral line) in migrating smolts. (2006)

   b. Determine if the route of passage (spill, turbine, and bypass) through the hydrosystem affects physiological dysfunction and delayed mortality in migrating salmon and steelhead smolts. (2005-2007)

2. Test the hypothesis that post hydrosystem survival (SARs) and the variability of seasonal differential delayed mortality "D" is dependant on the size, condition, and timing of fish arriving in the estuarine and marine environments for spring and summer Chinook salmon. (2006-2012)

SCHEDULE: 2000-2012 (includes adult returns)

CONTACT: Derek Fryer 509-527-7280

NOTES:
1. This work is closely related to the comparative survival studies of multiple bypass, in-river passage and transportation.
2. PIT tag detection capability through spillways and turbines would be extremely valuable for this program.

Northwestern Division -- Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: SPE-P-02-1

TITLE: Survival of Juvenile Salmonids at Bonneville Dam.

FISH PROGRAM FEATURE: In-river Passage, CRFMP — Bonn Juvenile Passage Studies.

UPA MEASURE: Hydro Sub Strategy 1.4, 66 (B2 CC), & 82 (spill survival).

MANAGEMENT PURPOSE: Perform an evaluation of the 7' versus 14' flow deflectors to determine if a construction or operational change towards improving juvenile fish survival through the Bonneville Dam Spillway is warranted.

SUMMARY: In 2001, new 7' flow deflectors were installed in bays 1-3 and 16-18 at the Bonneville Dam Spillway to complement the existing 14' flow deflectors at bays 4-15. In 2002, a balloon-tag study was conducted to assess the effects of 7' and 14' deflectors on fish injury and survival. These data suggested that during low tailwaters, direct injury and mortality was higher for fish passing the 14' deflectors, however the precision of those estimates was low. In 2004, total survival for yearling Chinook, steelhead, and subyearling Chinook was estimated for fish passing through spillbays with the two deflector types using radiotelemetry. These data also showed a trend toward lower survival for fish passing bays with 14' deflectors particularly at lower spill volumes. In addition, the 2004 results suggested that fish passing through the spillway had lower survival for lower spillway discharges. Following the 2004 test, it was discovered that spill volumes during the 2002 and 2004 studies were less than reported. The reported 50 and 75 kcfs spill volumes that resulted in the lowest survival estimates in 2004 were actually 48.1 and 23 kcfs once corrected. In 2005, the correct BiOp spill volume was implemented and the total survival of fish passing spillbays with the two deflector types will be estimated. If the 2005 data support the hypothesis that survival of yearling Chinook, steelhead, and subyearling Chinook is lower for fish passing through bays with 14' deflectors and/or at lower spill volumes, additional spillway survival testing will occur in 2006.

OBJECTIVES:

1. Estimate the direct effects on injury and survival (precision of ±4% at α=0.05) for yearling and subyearling Chinook passing through spillbays with both a 7' and a 14' elevation.
    a. At two discharges for each species
    b. At two tailwater elevations for each species.

SCHEDULE: 2006

NOTES:
1. If no problem is detected in 2005, this research effort may not be warranted for 2006.
2. 2007 and outyear work may include optimizing spill operations for adult and juvenile fish passage and evaluating B1 sluiceway improvements if warranted.

CONTACT: Dennis Schwartz (503) 808- 4779

Northwestern Division -- Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: SPE-P-06-NEW

TITLE: Effects of Total Dissolved gas on chum fry

FISH PROGRAM FEATURE: CRFM- System

BIOP MEASURE: none

Management Purpose: Concerns about the effects of total dissolved gas (TDG) on pre-emergent chum fry have restricted spill operations at Bonneville Dam. Field data is needed to verify this concern is warranted.

There are several spill operations which occur in the early spring at Bonneville Dam during the time when sac-fry chum are still present in the gravel. These operations include spill during a period of March for the Spring Creek Hatchery release, and spill beginning approximately April 10 for the juvenile migration.

The guidance that has been used to provide protection for chum rearing in the gravel has been to limit TDG to 105% after allowing for depth compensation. Thus, TDG can be as high as120% at the surface, but if three feet of depth compensation is provided, the level experienced by the incubating fry is theoretically 105%. The provision of depth compensation is possible in most years, but during periods of low flow, no depth compensation can be provided. This forces a decision as to whether spill should be provided to improve juvenile fish passage or limit spill to protect incubating chum.

The literature available regarding TDG exposure is largely based on long term exposure of eggs and fry in hatchery conditions. The exposure of juvenile chum rearing in the gravel in the mainstem Columbia River is quite different from the environment in which TDG exposure data has been acquired. Chum in the mainstem are believed to be influenced by groundwater to a large extent, and the TDG in the groundwater is unknown.

OBJECTIVES:

1. Measure TDG at chum redd sites below Bonneville Dam.
2. Evaluate chum salmon sac fry for physical response to ambient TDG levels.
3. If necessary conduct bioassay on the formation of gas bubble signs on chum fry at TDG levels ranging up to 120% saturation for periods of time ranging from several days to several weeks duration

SCHEDULE: 2006 to ?

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: SPE-P-00-8

TITLE: Juvenile Salmonid Survival Studies at The Dalles Dam

FISH PROGRAM FEATURE: CRFMP-In-river Passage, SCT Description – TD Project Survival Study

UPA MEASURE: Hydro substrategy 1.4; ESU Actions-The Dalles Dam

MANAGEMENT PURPOSE: To determine whether implementing a vortex suppression device in spillbay 6 will increase direct survival and reduce direct injury for fish passing The Dalles Spillway.

SUMMARY: Recent studies have shown that at current spill levels most juvenile salmonids pass The Dalles Dam (TDA) through the spillway. However, this research also indicates that there is a direct effect on smolt survival and injury for fish passing through the stilling basin, apparently influenced by lateral flow moving from south to north. To reduce this lateral movement through the stilling basin and improve survival, a spill wall was constructed in 2003-04 between spillbays 6 and 7. A 2-year post-construction evaluation of the spill wall and the resulting new spill pattern (spillbays 1-6) began in 2004. Research included both direct survival and injury studies (Hi-Z balloon tags) for fish passing through the spillway and overall project passage and survival using radio telemetry.

Releases of balloon-tagged yearling Chinook salmon made through spillbays 2 and 4 yielded estimates of direct survival ranging from 98.1 to 99.8%, and clean fish estimates of 97.0 to 98.1%. However, a large vortex that formed upstream of the tainter gate in Spillbay 6 was evaluated using hand tossed balloon-tagged hatchery yearling chinook salmon, yielding survival estimates of 85.1% with a clean fish estimate of 93.2%. Passage distribution and efficiency studies in 2004 indicated that more than 20% of all yearling and subyearling fish passing through the spillway passed through Spillbay 6. During winter, 2004-05 modeling studies showed that inserting a stoplog in the spillbay at the water's surface to a depth of approximately 3' helped suppress the vortex. The primary focus of this study will be to estimate and compare direct survival and injury rates resulting from passage through Spillbay 6 with and without vortex suppression and to fish released through Spillbay 4. Additionally, the USACE Portland District is currently pursuing a transition from radio telemetry to acoustic telemetry for use in estimating project and dam passage behavior and survival. Acoustic telemetry is an attractive tool because it eliminates the external antenna required in radio telemetry while providing fine scale and 3d behavior information and estimating passage efficiency metrics and passage survival. As part of this transition, pilot studies to evaluate detection capability and detection probabilities used in sample-size calculations and power analysis for future studies are needed.

OBJECTIVES:

1. Estimate and compare direct effects of spillway passage on yearling Chinook salmon survival (±3% at α=0.05) and injury passing through Spillbay 6 with and without vortex suppression at multiple release locations.
2. Estimate direct effects of spillway passage on yearling Chinook salmon survival (±3% at α=0.05) and injury passing through Spillbay 4.
3. Calculate detection probabilities for acoustic-tagged juvenile salmonids at multiple detection transects below TDA and conduct a power analysis to determine required sample sizes to meet a range of precision levels (±2, ±3, ±4, ±5%, all at α=0.05 and power of 0.8).
4. Estimate passage efficiency metrics (±4% at α=0.05) and total dam and route-specific survival (±4% at α=0.05) for yearling and subyearling Chinook salmon. (2007 placeholder)

SCHEDULE: 2006 - 2009

NOTE: Initially planned for 2005, this work is part of the post-construction evaluation of the spillway training wall, but was delayed due to mechanical issues associated with The Dalles spillway tainter gates and a resulting limitation in the ability to fluctuate gate openings to maintain the BiOp required 40% spill. This work is part of a long-term strategy to increase spillway passage survival for juvenile salmonids including the potential construction and implementation of a

forebay behavioral guidance structure (BGS). Tentative plans are for installation of a forebay BGS in 2007, a full evaluation of passage efficiency and survival would be implemented at that time.

CONTACT: Brad Eppard (503) 808-4780

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: SPE-P-00-7

TITLE: Juvenile Salmonid Survival Studies at John Day Dam

FISH PROGRAM FEATURE: In-river Passage, CRFMP-– JD Biological Studies

UPA MEASURE: Hydro substrategy 1.4; ESU Actions-John Day Dam

MANAGEMENT PURPOSE: Investigate the behavior and survival of juvenile Chinook salmon and steelhead in the John Day tailrace to determine if construction or operational changes can be made to increase project survival.

SUMMARY: From 1999-2003, spill was evaluated at John Day Dam (JDA) as a way to improve the survival for juvenile salmonids passing the project. Each year an alternative spill treatment was compared to the operation called for in the 2000 NMFS Federal Columbia River Power System Biological Opinion (BiOp). Fish passage metrics used to compare treatments included survival, fish passage efficiency (FPE), forebay retention time, and tailrace egress. Based on the results of this research, the Action Agencies implemented a 24-hour 30% spill operation at John Day Dam for summer-migrating subyearling Chinook salmon. In the springtime, the BiOp spill operation remains the status quo (0% day, 60% night).

Recent research has shown that survival estimates of fish passing through turbine units (and under some operations, the juvenile bypass system) are some of the lowest observed in the FCRPS and suggest that there is good potential for additional survival improvements at JDA. Juvenile salmonid tailrace behavior, model observations, and survival study results point to the near-dam tailrace, in particular the area downstream of the skeleton bays, as a potential source of high smolt mortality. In 2006, tailrace egress and survival will be evaluated for turbine-passed fish to better partition mortality and focus future survival improvement work. Additionally, the Corps is currently pursuing a transition from radio telemetry to acoustic telemetry for use in estimating project and dam passage behavior and survival. Acoustic telemetry is an attractive tool because it eliminates the external antenna required in radio-telemetry while providing fine scale and 3d behavior information and estimating passage efficiency metrics and passage survival. As part of this transition, pilot studies to evaluate detection capability and detection probabilities used in sample-size calculations and power analysis for future studies are needed.

OBJECTIVES:

1. Conduct a power analysis to determine yearling and subyearling Chinook sample size requirements for detecting a 1%, 2%, 3%, 4%, 5%, and 6% difference in turbine survival estimates (between two turbine operations) at $\alpha = 0.05$ and 0.10 and $\beta = 0.2$ and 0.1.
2. Estimate turbine passage survival from release into a turbine-unit intake to the tailrace front roll (±4% at α=0.05) at two operating points for yearling and subyearling Chinook salmon and steelhead.
3. Estimate tailrace passage survival from release into the tailrace front roll to a tailrace release site near the public boat launch at French Guiles Park (±4% at α=0.05) at two turbine operating points (See Note) for yearling and subyearling Chinook salmon and steelhead.
4. Estimate turbine and immediate tailrace passage survival from release into a turbine intake to a tailrace release site near the public boat launch at French Guiles Park (±4% at α=0.05) at two operating points (See Note) for yearling and subyearling Chinook salmon and steelhead.
5. Evaluate travel paths and tailrace residence times for yearling and subyearling Chinook salmon and steelhead released as part of Objective 1 and for drogues released into the tailrace front roll.
6. Calculate detection probabilities for acoustic-tagged juvenile salmonids at multiple detection transects below JDA and conduct a power analysis to determine required sample sizes to meet a range of precision levels (±2, ±3, ±4, ±5%, all at α=0.05 and power of 0.8).

SCHEDULE: 2006

NOTE: 1. The specific turbine unit(s), turbine geometry, operating efficiency, and release location(s) for this study will be determined under the Turbine Survival Program through model work on a newly constructed sectional model and the existing general model (Summer, 2005).

2. Precision for turbine survival estimates in objectives 2-4 will depend on power analysis conducted in objective 1.

CONTACT: Brad Eppard (503) 808-4780

Northwestern Division- Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: SPE -W-04-3 Also see SBC-W-06-(new).

TITLE: Juvenile Salmonid Survival Studies at McNary Dam

FISH PROGRAM FEATURE: Inriver Passage and Survival. CRFMP – MCN Survival/Efficiency Study

UPA MEASURE: Hydro substrategy 1.4; ESU Specific Actions - McNary Dam

MANAGEMENT PURPOSE(s): Optimize spill operations to maximize juvenile salmonid survival. Gather baseline passage and survival data for post-construction evaluation of McNary Modernization and Surface Flow Bypass alternatives.

MANAGEMENT PURPOSE(s): Optimize spill operations to maximize juvenile salmonid survival. Gather baseline passage and survival data for post-construction evaluation of McNary Modernization and Surface Flow Bypass alternatives.

SUMMARY: Recently, it has been proposed that 24-hour spill at McNary Dam (MCN) may provide a means to improve project survival of juvenile salmonids. Currently at MCN, the 2000 Biological Opinion calls for spill to the gas cap from 1800 – 0600 hours daily beginning in early-April and continuing through mid-June. It is thought that providing spill over the entire 24-hour period rather than just 12 hours per day at night may improve overall dam survival of juvenile salmonids by potentially reducing forebay residence time for juvenile migrants during the day and by providing better tailrace egress conditions by balancing powerhouse and spillway flow over a 24-hour period. In 2005, a 12 versus 24-hour (85 kcfs) spill evaluation is underway to determine if potential survival benefits may be realized from 24-hour spill. Depending on results from the 2005 evaluation, an additional year's evaluation may be necessary to determine the effects of 24-hour spill on juvenile salmonid survival. Additionally, surface bypass concepts are being developed in 2005. The effect of 24-hour spill on juvenile salmonid survival is anticipated to provide insight for the design of and potential benefit of surface bypass at MCN. Baseline subyearling Chinook passage and survival data under existing operations are needed to determine the potential benefit surface bypass or other operational or structural changes at the project may provide. Objectives below will be integrated with those discussed in SBC-W-06-(new) Studies of Surface Flow Bypass at McNary Dam.

OBJECTIVES:

1. Estimate dam and route specific survival rates of yearling chinook salmon under two spill operations (±3% at α=0.05).
   a. Estimate fish passage efficiency, fish guidance efficiency, and spill passage efficiency for yearling Chinook salmon under two spill operations.
   b. Evaluate the forebay retention time of yearling Chinook salmon passing the project under two spill operations.
   c. Monitor the tailrace egress of yearling Chinook salmon passing the spillway and bypass system outfall under two spill operations.
2. Estimate dam and route specific survival rates of juvenile steelhead for two spill operations (±3% at α=0.05).
   a. Estimate fish passage efficiency, fish guidance efficiency, and spill passage efficiency for juvenile steelhead under two spill operations.
   b. Evaluate the forebay retention time of juvenile steelhead passing the project under two spill operations.
   c. Monitor the tailrace egress of juvenile steelhead passing the spillway and bypass system outfall under two spill operations.
3. Estimate dam and route specific survival rates of dsubyearling Chinook salmon under spill and non-spill operations (±3% at α=0.05).
   a. Estimate fish passage efficiency, fish guidance efficiency, and spill passage efficiency for subyearling Chinook salmon under spill and non-spill operations.
   b. Evaluate the forebay retention time of subyearling Chinook salmon passing the project under spill and non-spill operations.

c. Monitor the tailrace egress of subyearling Chinook salmon passing the powerhouse and bypass system outfall under spill and non-spill operations.

SCHEDULE: 2006

CONTACT: Dan Feil, 509 527-7295

Northwestern Division – Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: SPE-W-04-4

TITLE: Fish passage and survival at Lower Monumental Dam

FISH PROGRAM FEATURE: Inriver passage and survival. CRFMP – LoMo Survival/Efficiency Study

UPA Measure: Hydro Substrategy 1.4, p. 19, Key Alternatives under Development, p.38.

MANAGEMENT PURPOSE: Perform pre-construction evaluation at Lower Monumental Dam to obtain baseline data on juvenile salmon distribution and behavior in the forebay, and project survival. Future construction and operations considerations include an RSW and alternative spill operations.

SUMMARY: Lower Monumental Dam has shown a range of project survival estimates depending on the river flow and spill level that existed at the time of testing. Spillway survival estimates from 2003 research, when using a flat spill operation, tended to be higher when river flows were higher. In 2004, "high gate opening" spill was studied and yielded an overall spillway survival estimate of 96.1%. Because of the differences between the years, the Corps attempted to obtain an additional year of data for verification. However, the planned study for 2005 was changed due to river flows being lower than the threshold for maximizing transportation, and the study was then modified to obtain information deemed critical by the region to siting an RSW in spillbay 8. The need for forebay residence and mortality information, along with other passage metrics and spill passage efficiency estimates are still necessary. An RSW is planned for implementation in 2007 and survival data with bulk spill will be important for making comparisons with RSW performance.

OBJECTIVES:

1. Estimate forebay residence time for yearling Chinook, subyearling Chinook, and steelhead. Estimate tailrace egress from all passage routes [+/- 5%, $\alpha = .05$]. (2004-2008)
2. Estimate Spill Passage Efficiency and Fish Passage Efficiency during high gate opening spill conditions for yearling Chinook, subyearling Chinook, and steelhead. These should provide benchmarks for comparison with RSW performance in 2007. (2004-2008)
3. Estimate project and route specific survival with high gate opening spill operations for yearling Chinook , subyearling Chinook, and steelhead. [$\alpha = .05$ +/- 5%] (2006)
4. Test for significant differences in Project and Spillway survival between an RSW operation and high gate opening spill conditions (2007-2008)

SCHEDULE: 2003-2008

CONTACT: Ann Setter 509-527-7591

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: SPE-W-04-2

TITLE: Fish passage and survival at Little Goose Dam.

FISH PROGRAM FEATURE: In-river passage and survival. CRFMP – LGo Survival/Efficiency Study.

UPA MEASURE: Hydrosystem Sub-strategy, 1.4, page 19; ESU Specific Action pages 33, 39, and 43.

MANAGEMENT PURPOSE: Perform pre-construction evaluation at Little Goose Dam to obtain baseline data on juvenile salmon distribution and behavior in the forebay, and project survival. Future construction and operations considerations include an RSW, a training wall between the powerhouse and spillway, and alternative spill operations.

SUMMARY: There is currently very little data concerning juvenile fish survival and passage at Little Goose Dam. Survival estimates have been derived primarily as a result of data gathered for two previous studies (i.e. "Behavior and Survival of Radio-Tagged Juvenile Chinook Salmon and Steelhead Relative to the Performance of a Removable Spillway Weir at Lower Granite Dam, Plumb et. al, April 2004" ; and "Survival Estimates for the Passage of Juvenile Chinook Salmon through Snake River Dams and Reservoirs, BPA Annual Report, 1993". Studies at Little Goose in 2005 are expected to produce estimations in Fish Guidance Efficiency, tailrace and forebay survival, and low flow bypass and turbine survival. An option under consideration for this study is a two treatment test, with and without daytime spill. This would improve ability of the study to provide input on surface bypass how fish would respond to a bypass and also inform operations alternatives.

RESEARCH OBJECTIVES:
1. Estimate fish guidance efficiency (FGE) for yearling Chinook, steelhead and sub-yearling Chinook at $\leq \pm$ 5%, α=0.05. **2006-2007**
2. Estimate dam, reservoir, and route-specific survival for yearling Chinook, steelhead and sub-yearling Chinook using two test operations at $\leq \pm$ 3%, α=0.10. **2006-2007**
3. Determine forebay behavior patterns for yearling Chinook, steelhead and sub-yearling Chinook to aid in locating an RSW. **2006-2007**
4. Estimate fish passage efficiency (FPE) for yearling Chinook, steelhead and sub-yearling Chinook using two test operations, evaluating at $\leq \pm$ 5%, α=0.10. **2006-2007**
5. Estimate direct injury and survival of fish passing spillways. **2007**
6. Estimate tailrace egress for all passage routes, including passage time and route, for spring and summer test operations. **2006 – 2007**
7. Optional Drought Objective: If there are no spill operations at Little Goose Dam as a result of drought conditions, continue the research on objectives that are not dependent on spill.

SCHEDULE: 2006-2008

CONTACT: Fred Higginbotham, 509-527-7236

Northwestern Division – Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: SPE-06-(New)

TITLE: Establish and Evaluate Specification Criteria for an Active/Passive Migratory Life-Cycle Transmitter

FISH PROGRAM FEATURE: CRFMP-In-river Passage

UPA MEASURE: Hydro Substrategy 1.4; RM&E Substrategy 1.1 Page 89.

MANAGEMENT PURPOSE: Development of a tool that would allow for complete evaluation of passage behavior and survival from the juvenile through adult life stages for salmonids migrating through the FCRPS to meet performance standards establish in the 2000 NMFS Biological Opinion.

SUMMARY: The listing of Pacific Salmon and steelhead under the Endangered Species act has required that biological opinions (BiOps) and recovery plans for listed species be developed. These BiOps have established measures for reducing the mortality of salmon related to passage through the Federal Columbia River Power System (FCRPS). Along with these measures the BiOps have establish performance measures related to survival of juvenile salmon through the entire FCRPS. To evaluate these measures the Action Agencies have employed both passive and active tag technology. Due to the limitations of both tag types, it has not been possible to evaluate both behavior and survival through the entire system using the same fish to date, especially, for subyearling Chinook salmon.

Passive tags (PIT tags) have been used to conduct migration timing studies as well as estimate both short term (project or reach) and long term (SAR rates) survival for juvenile salmonids since the late 1980's. These tags allowed researchers to tag a large quantity of fish as small as 50 mm with uniquely coded tags that last indefinitely. The primary disadvantage of the PIT tag has been the range at which the tag can be detected, tagged fish must pass through an antenna emitting a magnetic field that activates the tag and subsequently receives the coded transmission. Typically, PIT-tagged fish are only detected if they pass through the juvenile bypass systems at dams in the FCRPS. This limitation has precluded the use of PIT tags to evaluate passage behavior and survival relative to changing operations at dams within the Columbia River Basin and especially in the lower river where detection capability is limited. Additionally, this limitation has led to the wide use of active tags to conduct evaluations on both behavior and survival for juvenile salmonids. Use of active tags has increased dramatically since the mid 1990's with radio telemetry being the primary tool. Radio telemetry has been an attractive and useful tool because it allows for evaluation of fish behavior relative to changes in dam operations as well as survival estimation in reaches where PIT-tag detection does not exist or is not feasible. The methodology used in these studies require the implantation of a transmitter with an antenna that remains external to the fish.

Whereas, radio telemetry has been a useful tool in measuring behavior and survival over short reaches, numerous laboratory and field studies have indicated that the presence of a radio tag does impact the long term fitness and survival of juvenile salmonids. Over the years, tag manufactures have been working to minimize the size and weight of these transmitters while maintaining tag life and sufficient detection capability by reducing the size of electronic components and more recently exploring ways to reduce the length and weight of the transmitter's antenna hoping to further reduce the deleterious effects caused by the tags presence. Even with the reduction in antenna length and overall weight of radio tags, acoustic telemetry is fast becoming a more attractive tool for survival estimation primarily because it eliminates the external antenna altogether. Innovations in this field have also allowed for the production of sub-gram active tags. Further innovations are leading to the development of a combined active/passive tag, one that would be active while within an area of interest (a dam) and passive when outside that same area. Development of this tag would allow the action agencies to track salmonids through their migratory life cycle evaluating passage behavior, timing, and survival through the FCRPS.

The purpose of this study would be to establish criteria/goals for the size and shape of an active/passive transmitter that would minimize or eliminate impacts to tagged fish.

OBJECTIVES:

1. Establish goals and specification criteria for properties (i.e. size, shape, and potting material) of a migratory life-cycle transmitter. (2006)

2. Conduct laboratory experiments to evaluate and compare the long term effects on subyearling Chinook salmon of implanted dummy transmitters that meet the specifications established in Objective 1. (2006-?)
   a. Evaluate swimming performance.
   b. Evaluate long term tag retention.
   c. Evaluate growth rates.

3. Conduct field experiments to evaluate the performance (travel time, detection probabilities, and survival) of subyearling Chinook salmon tagged with dummy transmitters that meet the above criteria compared to those tagged with standard PIT-tags. (2007-?)

SCHEDULE: 2006 - 2007

CONTACT: Brad Eppard (503)808-4780

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: SPE-06-(New)

TITLE: Effects of Load Following on Reservoir Hydraulics, Juvenile Salmon Migratory Behavior, and Survival

FISH PROGRAM FEATURE:

BIOP MEASURE: None

SUMMARY: Average flows and project spills in the Columbia and Snake rivers during 2001 were some of the lowest on record and the in-river survival of outmigrating juvenile salmonids were very poor. Low river velocities reduce juvenile migration rates, thus likely increasing their vulnerability to predators, resulting in reduced survival. We hypothesize that load following operations at dams may exacerbate the negative effects of low flows and that more than low average flow/velocity may cause poor juvenile fish survival. Following electrical load at hydro projects causes flows to fluctuate on a daily cycle between higher flows during peak power generation and lower flows during off-peak demand. At lower river flows, load following operations have greater impact on river hydrodynamics. The daily load-following cycle may result in changing flows, velocities, and wave phenomena in each reservoir and may induce changing hydraulic patterns for migrating smolts. Hydraulic conditions in rivers and reservoirs provide important behavioral cues for juveniles. During periods of low flow and reduced spill, smolts have been observed milling in dam forebays and moving upstream to a greater extent than under higher flow and spill conditions.

An experiment that separates the effects of low average flow from the effects of fluctuating flows is needed. The question, which could be addressed in this experiment, is whether the slow migration speeds often observed during low-flow conditions are in large part a consequence of abnormal cycles of flow interruption induced by load following at the dams, or a consequence of low flow itself. The essential hypothesis justifying the experiment is that a pattern of relatively constant low flow would prove less damaging to migration speed and in-river survival rates than would the pattern of load following imposed on the same average flow level.

Radio or acoustic-tagged smolts could provide behavioral data to assess the effects of the two test conditions. Because the sample sizes required to estimate survival are much greater than to evaluate behavior, during the first year of study, only reservoir hydraulics and fish behavior would be evaluated. Survival estimation under the two test conditions would be added as an objective in future years if the results obtained in the first year of study found that hydraulic conditions and migration rates were significantly affected. Because the negative effects of load following are likely greatest at lowest flows, this experiment should be conducted during the summer migration (or under extreme low spring flows should they occur). A summer test would also reduce the confounding affects of spill in the analysis.

OBJECTIVES:
1. Study flow fluctuations and hydraulic conditions in the Lower Snake River during periods of load following and constant flows.
2. Describe behavior and migration patterns of out-migrating juvenile salmonids during periods of load following and constant flows.
3. Estimate juvenile survival during periods of load following and constant flows (dependent on results from objectives 1 and 2).

SCHEDULE: 2006 to ?

CONTACT: Bruce Suzumoto (503) 222-5161 or Jim Ruff 503-230-5437

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: SBE-P-00-17

TITLE: Studies of Surface Flow Bypass at The Dalles Dam.

FISH PROGRAM FEATURE: CRFMP - TD - Surface Bypass.

UPA MEASURE: UPA: Hydro sub strategy 1.4; ESU Actions-TDA

MANAGEMENT PURPOSE: To collect information on fish behavior that can be used to design alternatives that reduce turbine entrainment and increase dam survival.

Much of the research completed to date at The Dalles Dam (TDA) has focused on estimating fish passage and survival through various passage routes. In 2003, 2004, and 2005, additional studies were initiated to help describe fish distribution and define the approach paths of fish entering the forebay and passing the dam. In 2003, a hydroacoustic study was initiated to collect general, population level information on fish distribution (vertical and horizontal) in the forebay of TDA. In 2004, 3-D acoustic telemetry is being used to obtain information on individual fish behavior in the forebay of TDA. Additionally, in 2004, efforts to optimize sluiceway operations to maximize fish passage through the sluiceway showed that it was preferable to open six gates rather than three; the question remains: which six gates? In 2005, sluiceway optimization and survival studies are being conducted.

The primary goal of the "forebay" research program is to gather information on how fish approach and pass TDA. This information will aid in design a forebay guidance structure, optimization of sluiceway operations, and possibly development of surface flow outlet(s) at the spillway and/or powerhouse. For example, the goal of a forebay guidance structure planned for deployment in FY07 would be to effectively reduce turbine passage under current BiOp spill levels (40%) and either maintain or further reduce turbine passage under reduced spill conditions. Design and construction of a forebay structure are planned for 2005-2007. Post-construction evaluation of the structure would occur in 2007-2008.

Assuming any prototype forebay structure will not be moved in and out for the purpose of evaluation, it will be important to characterize baseline conditions (without the forebay structure) for turbine, sluiceway, and spillway passage by updating the synthesis report for 1982-2000. Recent progress in integrating computational fluid dynamic (CFD) model outputs with individual fish behavior data show promise in forecasting how downstream migrants might respond to hydraulic and structural elements they encounter as they approach the dam during their emigration. Pending further development and validation of the Numerical Fish Surrogate (NFS) model at TDA, the Portland District intends to use the NFS to help determine an optimal design and location of a forebay structure that will help reduce turbine passage and ultimately improve fish survival.

OBJECTIVES:

1. Update the 1982-2000 synthesis report with data from 2001-2005, including a characterization of baseline passage conditions at TDA (pre-forebay guidance structure **2006**).

2. Estimate spill passage efficiency, sluice passage efficiency, and fish passage efficiency during spring and summer (post-forebay guidance structure **2007-2008)**

3. Characterize individual approach paths and determine passage fate of juvenile salmon (yearling chinook, steelhead, sockeye and subyearling chinook) within the entire forebay up to 2000' upstream of the east end of the powerhouse. (post-forebay guidance structure **2007-2008)**

4. Estimate vertical and horizontal fish distribution within the entire forebay up to 2000' upstream of the east end of the powerhouse. (post-forebay guidance structure **2007-2008)**

5. Integrate CFD model outputs of representative hydraulic conditions with fish approach path and distribution data. (post-forebay guidance structure **2007-2008)**

SCHEDULE: 2003 – 2008

CONTACT: Bernard Klatte (503) 808-4773

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: SBE-W-05-1

TITLE: Fish passage and survival at Ice Harbor Dam Removable Spillway Weir

FISH PROGRAM FEATURE: CRFM – IH - RSW

BIOP MEASURES: Hydrosystem Substrategy 1.1, p. 18; ESU Specific Action, Ice Harbor Dam RSW, p 38, Configuration Changes, p 45.

MANAGEMENT PURPOSE: Post construction evaluations to determine the optimal operation of Ice Harbor Dam RSW.

PROJECT INFORMATION: Spillway/Project survival studies have been conducted at Ice Harbor in previous years (2000 – 2004), and have indicated variable survival and injury depending on operations and fish release location. A Removable Spillway Weir (RSW) was installed at Ice Harbor Dam in 2005. Initial balloon tag survival and injury study was conducted in April 2005. Results were similar to conventional spillway passage, with high survival at shallow and deep release locations and relatively high injury rates at the deep release location. The 2005 hydroacoustic and radio-telemetry study treatments were "high gate opening gas cap spill" and "30% spill with RSW". Both treatments were 24 hours per day. Radio-telemetry study used yearling Chinook and steelhead in the spring and subyearling Chinook in the summer. Specific test operations for 2006 will be dependent on results from 2005. The initial plan was to confirm high passage and survival of fish passing over the RSW in 2005, and then refine the RSW operation in subsequent years. Deflector changes may be considered for 2006. It will be important to attempt to describe the vertical distribution of fish as they pass over the RSW crest. This will be accomplished either through hydroacoustics or some other method, possibly an acoustic camera.

OBJECTIVES:
1. Estimate percent passage by route (RSW, spill, bypass and turbine) for two test operations.
2. Estimate project and route specific survival for two test operations for steelhead, spring and summer Chinook. (Detect project survival difference of $\pm$ 4%, α=0.05)
3. Estimate tailrace egress (for all passage routes) for spring and summer test operations. This includes passage time and routing.
4. Estimate direct injury/survival of fish passing via RSW and conventional spillway (2005).
5. Determine vertical distribution of passage of fish at RSW crest.
6. Estimate RSW efficiencies over a range of RSW discharges.

SCHEDULE: FY05 – FY07

NOTES: Test operations dependent on results of 2005 studies.

CONTACT: Tim Wik 509-527-7276

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
STUDY SUMMARY

STUDY CODE: SBE-W-06-New

TITLE: Effects of Spillbay and Deflectors on Fish Injury

FISH PROGRAM FEATURE: CRFM- Surface Bypass (this may be a new SCT line item in FY06)

UPA MEASURE: Spillway Improvements – McNary, Ice Harbor, and Lower Monumental Dam, p. 37-39,

MANAGEMENT PURPOSE: Determine mechanism of injuries and mortality observed at Ice Harbor and other projects to ensure spillway and surface bypass routes are as safe as possible. The results of this study would guide development of spill patterns, spill levels, and design surface bypasses.

SUMMARY: Direct injury and survival studies have been conducted at the Ice Harbor Spillway in 2003, 2004 and 2005. Results from these studies have provided results that indicate fish injury varies based on flow levels, elevation of releases, and tail water levels. Injury levels ranged from 1% - 22% during these studies. Based on this research, there is an attempt to define hydraulic conditions that fish may pass during spillway passage, and relate them to potential for fish injury. Spillway survival has also been variable at Lower Monumental, seemingly related to tailrace elevation. Hydraulic model studies of deflector performance have suggested correlations between skimming flows higher mortality and injury.

Removable Spillway Weirs and other surface collection devices are being developed for other Lower Snake and Columbia River Projects. Information regarding fish injury and hydraulic conditions is essential the design, placement, and operation of spillways and surface bypass structures.

OBJECTIVES:
1. Estimate injury of yearling Chinook salmon under 3 varied hydraulic conditions (skim, plunge and undular flows) with the precision required to detect a 5% difference in injury between treatments.
2. Determine if injuries are caused by contact with the ogee, deflector, or by sheer.
3. Estimate injury of yearling Chinook salmon, of fish passing near spill walls with precision required to detect a 5% difference in injury levels.

SCHEDULE: 2006-2008

CONTACT: Marvin Shutters 509-527-7249

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: SBE-W-05-02

TITLE: Evaluation of the modified Behavioral Guidance Structure (BGS) at Lower Granite Dam.

FISH PROGRAM FEATURE: CRFMP – LGR - Surface Bypass Program

BIOP MEASURES: Hydrosystem Substrategy 1.1, page 18; ESU Specific Action: Project Configuration RM&E, Juvenile Fish Passage, p 43.

MANAGEMENT PRUPOSE: Determine if the modified BGS is effective at guiding juvenile salmonids to both help determine LGR configuration and to support design of any future BGS.

PROBLEM STATEMENT: The Lower Granite Removable Spillway Weir (RSW) was installed in spillbay 1 in 2001. Initial biological testing (survival) took place in November 2001, with a full biological test taking place in spring 2002. Testing continued in spring 2003, when the Surface Bypass Collector (SBC) and Behavioral Guidance Structure (BGS) were removed. In 2004, the BGS was moved to a new location between units 5 and 6. The depth of the BGS was also reduced. Unfortunately, low water supply precluded adequate testing of the new BGS configuration in 2004 and 2005.

Subyearling Chinook passage and survival through the Lower Granite RSW is scheduled for evaluation in summer, 2005. Current test plan is for evaluation of RSW vs. Non-RSW spillway passage. Results of 2005 study will determine 2006 specific objectives for subyearling Chinook at Lower Granite.

OBJECTIVES:
1. Determine the relative passage rates of juvenile salmonids through the powerhouse, bypass system, spillway and RSW, relative to the position of the BGS.
2. Determine the effectiveness and efficiency of the various passage routes of powerhouse, bypass system, spillway and RSW, relative to the position of the BGS.
3. Determine survival of yearling Chinook and steelhead relative to passage route and/or project operation. (+/- 3%)
4. Determine passage and survival of subyearling Chinook relative to operation of RSW and spillway. (Detect a survival difference of 4%)

SCHEDULE: 2006

CONTACT: Tim Wik 509-527-7276

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: SBE-W-06-NEW (Also See SPE-W-04-03**)**

TITLE: Studies of Surface Flow Bypass at McNary Dam.

FISH PROGRAM FEATURE: CRFMP – McN - Surface Flow Bypass

UPA MEASURE: Hydrosystem Substrategy 1: Mainstem Juvenile Passage Improvements

MANAGEMENT PURPOSE: Develop surface flow bypass concepts to improve juvenile salmonid survival at McNary Dam

SUMMARY: Much of the juvenile salmonid research conducted in recent years at McNary Dam (MCN) has focused on estimating fish passage and survival through available passage routes. However, little information exists that describes fish distribution in the forebay and the approach paths of juvenile salmonids entering the forebay and passing the dam. In 2005, an effort is underway to identify potential surface flow bypass (SFB) alternatives to optimize fish passage and survival at MCN, yet without information on how fish approach and pass the dam, settling on a final alternative(s) will be difficult. The primary goal of the MCN forebay research program in 2006 will be to gather forebay fish distribution, approach path, and passage information for juvenile salmonids passing MCN. This information will help guide SFB alternative selection and be integrated into the design phase to develop an effective SFB structure(s) for MCN that will improve fish survival under current UPA spill levels and either maintain or further improve survival under alternative operations.

OBJECTIVES:
1. Estimate the 3-dimensional forebay approach paths of individual juvenile salmonids (yearling Chinook, steelhead, sockeye and subyearling Chinook) within the entire forebay boat restricted zone and determine their passage fate under two project operations.
2. Estimate vertical and horizontal fish distribution of juvenile salmonids (yearling Chinook, steelhead, sockeye and subyearling Chinook) within the entire forebay boat restricted zone under two project operations.
3. Compare the 3-dimensional forebay approach paths of turbine vs. bypass vs. spill passed juvenile salmonids (yearling Chinook, steelhead, sockeye and subyearling Chinook) under two project operations.
4. Estimate spill passage efficiency, fish guidance efficiency, and fish passage efficiency during spring and summer under two project operations.
5. Integrate CFD model outputs of representative hydraulic conditions with fish approach path and distribution data *(placeholder)*.

SCHEDULE: 2006 – 2009

CONTACT: Dan Feil 509 527-7295

Note: These objectives would also meet most of the objectives of SPE-W-04-03

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: SBE-P-03-01 (also see SBC-W-06-01)

TITLE: Linking Juvenile Salmonid Behavior to Hydraulic Variables

FISH PROGRAM FEATURE: CRFMP – Surface Flow Bypass

UPA MEASURES: Hydrosystem Substrategy 1: Mainstem Juvenile Passage Improvements

MANAGEMENT PURPOSE: Improve passage efficiency and economize construction costs of future planned surface flow bypass structures

SUMMARY: The U.S. Army Corps of Engineers' surface flow bypass (SFB) program was initiated in 1994 to "develop and evaluate surface bypass and collection prototype concepts that will lead, if justified by prototype test results, to permanent systems for improving survival of juvenile salmon". The initiation of this program was prompted by the apparent effectiveness of a SFB at Wells Dam and sluiceways at Bonneville, Ice Harbor, and The Dalles dams. Passage effectiveness at these sites warranted investigation of SFBs as a means to safely and efficiently bypass juvenile salmonids at Columbia and Snake River dams. Subsequently, prototype surface collectors were evaluated at both Bonneville, from 1998 to 2000, and Lower Granite, from 1994 to 2000. Results of these evaluations differ to some extent and suggest that the collection or passage efficiency of these SFBs may be determined by juvenile salmonids' behavioral response to hydraulic conditions that are not thoroughly understood. Additionally, the vertical distribution of juvenile salmonids entering forebays may determine the efficiency of SFB systems. There is evidence that suggests a relatively high percentage of downstream migrants may encounter entrances to SFBs, yet are reluctant to enter and pass, presumably due to the hydraulic signature near bypass entrances. With the ongoing development of RSWs throughout the Region, there is a need to more fully understand how juvenile salmonids respond to the hydraulic signatures of existing SFB structures. The B2 corner collector and TDA sluiceway both are a sharp-crested weir design whereas the RSW design relies on controlling the hydraulic acceleration at the structure entrance, yet both designs seem to pass fish very efficiently. This may suggest that SFB efficiency is more dependent on physical location of the structure relative to how fish approach the dam rather than SFB entrance hydraulics. If this is the case, economies may be realized in future development of SFB structures by placing more emphasis on SFB placement relative to fish approach rather than SFB entrance hydraulics. Effort in 2006 will be focused on evaluating fish responses to hydraulic variables near RSW entrances (Ice Harbor and Lower Granite) and comparing that with the response of juvenile salmonids at SFB entrances at other sites (B2 corner collector and TDA sluiceway).

OBJECTIVES:
1. Quantify juvenile salmonids' response to various hydraulic variables at a Removable Spillway Weir entrance (Lower Granite and/or Ice Harbor) or other structure.
2. Describe and compare the hydraulic signatures of surface bypass entrances at Bonneville, The Dalles, Ice Harbor RSW, and Lower Granite RSW.
3. Compare fish response and hydraulic characteristics between sites (Bonneville, The Dalles, Ice Harbor RSW, and Lower Granite RSW).
4. Determine if there is an acceleration threshold in approach velocity to a surface bypass entrance that causes migrating juvenile salmon to reject surface bypass entrances.

SCHEDULE: 2006-2008

CONTACT: Dan Feil, 509 527-7295

Northwestern Division – Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
STUDY SUMMARY

STUDY CODE: SBE-W-06-01

TITLE: Evaluate RSW Performance under a range of discharges / High Q

FISH PROGRAM FEATURE: CRFM – LoMo RSW

UPA for BIOP REMAND: Key Alternatives under Development, p.38.

MANAGEMENT PURPOSE: Determine if low injury fish passage can be achieved when a larger amount of flow is passed over an RSW

PROJECT INFORMATION:
Removable Spillway Weirs (RSW's) are now installed at two Snake River dams, Lower Granite and Ice Harbor. RSW's provide a surface passage route through a spillbay and have been shown to pass fish with high survival (98%) at Lower Granite. The physical environment that the presence of this structure creates is being reexamined to determine if more fish would locate and utilize it if a greater volume of flow were passing through it. In order to test this concept, a direct injury study would be conducted utilizing two different forebay elevations. This will allow a test of two different flow discharges (Q) through the RSW, 7kcfs and 9kcfs. Because of the change in acceleration velocities with increased Q, there is concern that fish might be more likely to sustain injury. Present acceleration criteria that exist are a design limitation within the existing spillbay width to building a structure with this increased capacity.

OBJECTIVES:
1. Determine if the amount of fish injury changes when discharge through an RSW increases by >20%.
2. Classify and document the type of fish injury that occurs and the cause.
3. Evaluate if fish passage behavior changes around the RSW entrance at different Q's.

SCHEDULE: 2006-2007

CONTACT: Ann Setter 509-527-7591

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: SBE-W-06-02

TITLE: Evaluation of the effects of vertical temperature gradients on the effectiveness of surface bypass systems at Snake River dams.

FISH PROGRAM FEATURE: CRFM – LoMo RSW

UPA Measure: Key Alternatives under Development, p.38.

MANAGEMENT PURPOSE: Determine if flow augmentation reduces the effectiveness of surface bypass by keeping water of a preferred temperature range along the bottom of the reservoir above Lower Granite Dam

Surface heating and cool water temperature releases from Dworshak Dam combine to create a complex spatial and temporal temperature distribution in Snake River reservoirs in the summer. Spatial and temporal observations of fish utilization of the reservoir and immediate forebay are needed to evaluate whether increased summertime temperatures in the upper part of the water column could reduce the effectiveness of surface bypass systems. If fish (subyearling Chinook) are actively avoiding zones of increased water temperature, then passage via the surface bypass route may be decreased as compared to springtime conditions when water column temperatures are more uniform.

OBJECTIVES:

1. Characterize individual 3-dimensional approach paths and determine passage fate of juvenile salmon (subyearling Chinook).
   a. Compare approach paths of turbine vs. surface bypass vs. spill passed juvenile salmon (subyearling chinook).
   b. Characterize individual vertical and horizontal fish distribution within the entire forebay up to 2000 ft. upstream of the east end of the powerhouse.
2. Characterize individual fish arrival times and vertical elevation at reservoir locations several kilometers upstream of the forebay.
   a. Compare vertical water column use in the open reservoir to the immediate forebay region.
3. Measure vertical water temperature distribution in the reservoir and forebay .
   a. Compare vertical fish locations to vertical water temperature distributions.
4. Integrate computational fluid dynamics (CFD) model outputs of representative hydraulic conditions in the reservoir, forebay, and bypass system entrance with fish approach path and water temperature data.

SCHEDULE: 2006 - 2008

CONTACT: Ann Setter 509-527-7591

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: ADS-00-1

TITLE: Evaluation of Adult Salmon and Steelhead Delay and Ladder Fall Out at Snake and Columbia River Dams.

FISH PROGRAM FEATURE: Adult Passage. CRFMP - tSYS Fish Ladder Transition Pool and Weir Mods

UPA MEASURE: Hydro Sub strategy 1.4, p. 19; ESU Specific Action, Adult Fish Passage, p 44.

MANAGEMENT PURPOSE: Determine if the transition pool modifications at Lower Granite Dam reduced adult salmonid passage times and if this ladder modification is applicable at other dams towards decreasing the adult passage times through the entire FCRPS.

SUMMARY: Compilation of past radiotelemetry data shows that median project passage times for adult salmon and steelhead ranges from 30 to 60 hours each for Bonneville, The Dalles, and John Day dams. Historic studies point to fallback, the time to first entrance, and the time spent in transition pools, as the primary areas of delay at projects. Experimental weir modifications in the transition pool of Lower Granite Dam (LGR) reduced ladder fallout and passage times for spring and summer Chinook (2.2 hr reduction in transition pool passage). Permanent modifications to the junction pool and transition pool are expected in January and February 2006. A post construction evaluation will begin immediately. It is not possible to do any kind of blocked effects study of these modifications; only a before and after. Therefore, it will not be possible to separate the confounding of year effects from modification effects. A potential control is to test passage rates at Little Goose which has not been modified to determine if any significant year effect is noted. Several years of passage data for Lower Granite and Little Goose have been collected.

If this research demonstrates that permanent modifications at LGR were effective, similar modifications could be applied and evaluated at other dams where deemed necessary. The north ladder at John Day Dam is one location where modifications to reduce passage times may be warranted. This ladder has a history of slower passage times, high incidence of fish moving up and down through the count station, and high ladder fallout. The south ladder has undergone modifications to the flow control section that have greatly reduced both fish jumping and passage times. FFDRWG agreed that the COE should put together a plan for additional modifications at John Day Dam, especially the north ladder, to improve adult passage. Once improvements are made evaluations of their effectiveness will be needed.

OBJECTIVES:
1. Estimate passage times and success rates of spring/summer Chinook, steelhead, and fall Chinook through the junction pool, transition pool, and entire LGR fishway with the modified junction pool, and transition pool and test for significant differences between these and past years data without modifications. Tagging of 200-400 of each species evaluated will be needed to reach adequate statistical precision. 2006.
2. Estimate passage time and success rates of spring/summer Chinook, steelhead, and fall Chinook through the junction pool, transition pool, and entire Little Goose fishway and test for significant differences between these and past years data. This is to provide a control for year effects in passage rates and success. 2006
3. Evaluate passage (passage times, ladder fallout, and up-down movements through the count station) at the modified JDA north ladder. 2008.

SCHEDULE: 2006-2008

CONTACT: Derek Fryer (509) 527-7280

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: ADS-00-4

TITLE: Investigation of Straying in Adult Salmon and Steelhead. (RM&E)

FISH PROGRAM FEATURE: Adult Passage, CRFMP – tSYS Adult Passage AFEP & O&M – Adult Passage

UPA MEASURE: Hydro Sub strategy 1.4, p. 19; ESU Specific Action, Adult Fish Passage, p 44.

MANAGEMENT PURPOSE: Develop in-stream PIT detection at tributaries where adult salmonids are known to stray to better quantify required annual system survival estimates.

SUMMARY: Between 2000 and 2003, fish of known origin (PIT tagged as juveniles) were radio-tagged and tracked on their migration routes, yielding a better understanding of the extent and nature of permanent straying. Mean straying rates varied from around 2.5% for all sp/su Chinook to 7% for all steelhead. Most mainstem straying occurred in the Deschutes, John Day, White Salmon, Little White Salmon, Wind, and Klickitat rivers. While straying is a natural characteristic of salmon populations that serves to colonize vacant habitat, and to increase genetic diversity, excessive straying can genetically swamp locally adapted populations. Recent radio-telemetry and PIT data indicate there may be a relationship between transport as a juvenile and an increased propensity to stray or fallback.

Straying rates are an essential adjustment factor to adult survival estimates used to evaluate whether the adult BiOp survival goals are being met. At present, system wide radio-telemetry is the only methodology to obtain straying rates representative of the ESUs. We are attempting to model straying based on data through 2003, but the limited number of years makes it difficult. Mean values from the years of radio-telemetry studies can be used as a correction factor for assessing adult performance but that would not reflect any annual variation that might normally occur. An alternative is to develop tributary PIT detection systems that can give us annual estimates of straying into some or all of the primary straying streams.

OBJECTIVES:

1. Finalize Summary Reports
    a. Compare straying of known source fish to determine stock differences in behavior. (2006). **O&M**
    b. Evaluate the ability to model straying rates to environmental conditions to be able to estimate straying rates for BIOP survival goal estimates. (2006). **O&M**
    c. Estimate effects of juvenile transportation on straying rates as adults. (2006). **O&M**
2. Evaluate feasibility of using tributary PIT tag systems to estimate straying. 2006-2007. **CRFMP**
3. Estimate straying rates for known source ESU or ESU surrogate fish for BIOP survival goal evaluations. 2006-2010. **CRFMP**

SCHEDULE: 2000 - 2010

CONTACT: David Clugston (503) 808-4751

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: ADS-00-5

TITLE: Temperature and dissolved gas exposure of adult salmon and steelhead migrants.

FISH PROGRAM FEATURE: Adult Passage. CRFM – tSYS Adult Passage temperature effects. & O&M Adult passage.

UPA MEASURE: Hydro Sub strategy 1.4, p. 19; ESU Specific Action, Adult Fish Passage, p 44.

MANAGEMENT PURPOSE: Determine if the water temperatures regimes experienced by adult fall Chinook and steelhead impair the population (migration and reproductive success), and if so, determine what hydrosystem configuration or operations could be changed to reduce the effects.

SUMMARY: Adult salmon and steelhead migrating to their natal streams in tributaries of the Columbia River must pass up to eight or nine dams: four dams each in the lower Columbia and Snake rivers, and five in the mid Columbia River. Adult migrants may encounter high river temperatures or supersaturated dissolved gasses en route to their spawning grounds. High temperatures may reduce reproductive success, increase susceptibility to disease, accelerate loss of energy reserves, extend passage delay and elevate stress of adult salmon and steelhead. Exposure to high levels of supersaturated dissolved gasses can be fatal to adult salmonids. Results from early years of this project determined that adult migration behavior allowed them to avoid the highest concentrations of dissolved and therefore unlikely to be effected by supersaturated gas. However, during most years water temperatures do rise to a level which alter behavior of fish causing migration delay in the Lower Columbia and Lower Snake Rivers. Steelhead will delay in cooler tributaries effectively reducing body temperatures. Preliminary evaluations point to an increase in escapement for steelhead using these cool water refugia but not for fall Chinook. This study has observed that cool water flow augmentation from Dworshak results in fish migrating faster and likely deeper in the Lower Granite Reservoir utilizing the cooler water that is strongly stratified. However, many fish hold at the confluence of the Clearwater River staying in the cooler water rather than continuing up the Snake River. The effects of this thermal exposure history and migration delay on survival and reproductive success is still under analysis. Last year, the study of egg viability as a function of temperature exposure history was hampered by logistic problems, resulting in smaller than planned sample size. Additional work may be required in 2006 to meet the study objectives.

The U of I telemetry study, has reported some temperature related migration delay, mostly correlated to large scale temperature patterns. However, temperature monitoring throughout all the upstream fishways has revealed temperature differences in the ladders that are of concern especially at Lower Granite during Dworshak flow augmentation, but also at other projects that warrant further biological investigation.

OBJECTIVES:

1. Evaluate potential effects of high water temperatures on survival, and reproductive success, including egg viability, for Snake River fall Chinook and Steelhead. 2003-2007
2. Determine effects of water temperatures differences within ladder on adult migrant passage timing and success. If problem areas exist, evaluate capability to alter water regime in ladders .2003- 2006.

SCHEDULE: 2000 – 2007

NOTE: This project is mostly completing analysis and reporting of data already collected, except the egg viability as discussed..

CONTACT: Karen Zelch 509-527-7255

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: ADS-00-13

TITLE: Effects of Dam Passage on Survival and Reproductive Fitness of Adult Salmon and Steelhead

FISH PROGRAM FEATURE: Adult Passage, CRFM– tSYS Adult Passage AFEP

UPA MEASURE: Hydro Sub strategy 1.4, p. 19; ESU Specific Action, Adult Fish Passage, p 44.

MANAGEMENT PURPOSE: To determine if there are delayed effects on spawning success related to passage history of salmonids (long passage times, reascension, temperature exposure) through the hydrosystem or if spawning ground conditions are primarily responsible for variations in spawning success

SUMMARY: Adult salmon and steelhead migrating to their natal streams in tributaries of the Columbia River must pass up to eight or nine dams: four dams each in the lower Columbia and Snake rivers, and five in the mid-Columbia River. While studies have documented direct mortality due to factors, such as fallback at these dams, little is known about delayed effects of dam passage on adult migrant survival and reproductive success. Fallback has also been linked to reduced system survival rates of 1-4 %. Excessive energy expenditure and exposure to adverse water quality are elements of dam passage that may have a delayed effect on adult salmon and steelhead survival and reproductive fitness. EMG data indicate that the tailrace of a dam is the area of highest energy use, followed by the ladder, and the forebay.

Understanding the spawning success of specific stocks with known passage histories (using radio telemetry and/or PIT tagged fish) can help determine the effects of dam passage on salmon return and reproductive success. Targeting additional PIT tagging efforts on specific stocks that can later be evaluated for passage history and spawning success and instigating the use of PIT tag readers by carcass survey crews should be initiated.

Results from the initial evaluations of spawning success of a small sample of known source RT and/ or PIT tagged fish on the South Fork Salmon and Yakima rivers found unsuccessful fish tended to have longer passage times, that nearly all fish reaching the spawning ground have adequate energy reserves, that temperature of spawning streams may greatly influence prespawn mortality, and that a non-lethal method of estimating fat content may be possible. Fish specifically PIT tagged for spawning success evaluations will be available in 2005 and 2007 for the South Fork Salmon River.

OBJECTIVES:

1. Evaluate potential effects of different upstream migratory passage histories on survival and reproductive success of known source fish. 2002-2009.
    a. Evaluate if reascension and/or passage time relates to spawning success and energy reserves.
    b. Assess the effect of high water temperatures on energy expenditure, survival, and reproductive success.
2. Implement targeted PIT tagging efforts that will enable future evaluations of spawning success of known history fish. Consideration should be made for adding other stocks. 2003-2009

SCHEDULE: 2000 – 2009.

CONTACT: David Clugston (503) 808-4751

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: ADS-P-00-8

TITLE: Adult Pacific Lamprey Passage at Columbia and Snake River Dams

FISH PROGRAM FEATURE: CRFMP - System - Adult Passage, CRFMP – tSYS Lamprey Passage Studies & O&M-Lamprey

JUSTIFICATION: The petition to list Pacific lamprey under the Endangered Species Act was denied due to insufficient information in 2005 and will likely be re-petitioned in 2006.

MANAGEMENT PURPOSE: Improve adult lamprey passage through the federal hydro-system to a level such that passage does not negatively affect population viability.

SUMMARY: Recent radio-telemetry data identified fish ladder entrances, entrance pools, and serpentine weirs as the primary obstacles to lamprey passage at Lower Columbia River dams. In 2000 and 2001, the effect of rounded entrance corners, floor diffusers, count stations, lighting, and entrance head were evaluated for lamprey passage. Diffuser gratings negatively affected lamprey passage but lighting did not. Reducing ladder flows at night to increase entrance use was evaluated in 2000 and 2001 with no noticeable improvements. There were also no consistent benefits from metal plates installed over diffuser gratings as they were positioned for the tests. Rounding of the corners at the spillway entrances improved passage.

Improving passage efficiency (% of adults that approach a dam that pass) and passage times are the primary means to minimize the effects of the FCRPS on lamprey populations. Only Bonneville, The Dalles, and John Day dams have adequate estimates of passage efficiencies. 2000-2002 average values for these three dams are 47, 74, and 53%, respectively. Twenty of 24 (83%) tagged fish that approach McNary Dam passed the dam for the three years combined. Very little is known about upstream passage at Snake River dams.

In 2005, PIT-tagged and radio-tagged lamprey will be released to obtain new passage efficiency estimates at BON, MCN and IHR. These estimates may help prioritize where improvements are most needed. Because it is the first dam on the river and because of the low passage efficiencies, Bonneville Dam has been the early focus of major adult passage evaluations and improvements. JDA is the logical second focus for such improvements because of its low passage efficiencies and downriver location but MCN may become another focus should 2005 evaluations find poor passage. The primary methods used to improve adult lamprey passage have been to provide better attachment sites, reduce structures and shapes that create difficulties to lamprey passage, refine dewatering procedures and structures to reduce stranding and mortality, and development of an alternative, lamprey-friendly, passage system (LPS) at fishway locations where passage is most problematic. Collecting information on fish behavior and swimming capabilities in the lab can help guide which types of modifications are likely to be effective.

OBJECTIVES:

1. Develop a lamprey passage system (LPS) at BON to produce at least a 10% increase in overall passage efficiency and prioritize additional locations for prototype LPS development based on worse passage and number of fish affected. (2003-2010).
    a. Evaluate the passage efficiency of the Bradford Island AWS LPS and compare to other routes using sufficient PIT tagged lamprey released below the dam to determine that at least 30% of lamprey entering the AWS pass via the LPS, producing at least a 10% increase in passage efficiency from that location. (2005-2006).
    b. Develop a prototype passage system at the WA north downstream ladder entrance area using adequate PIT-tagged fish to determine that at least 10% of fish entering that location are diverted into the LPS, which should result in a 5% passage efficiency increase for that entrance (2005-07).
    c. Perform lamprey flume evaluations of LPS components to determine optimal flow and ramp angles using 4-6 replicate trials and a precision of $\pm$ 5%. (2005-2007).
2. Assess the effect of above modifications on adult salmon and steelhead passage. All years.
3. Evaluate acceptable grating size and type to reduce stranding adult lamprey by at least 50% during dewatering and initiate installation without negatively affecting flow conditions. (2005-2010).
4. Estimate adult lamprey upstream passage success rates and passage times at JDA, MCN and Lower Snake River Dams. (2005-2010).

SCHEDULE: 2005 – 2010.

CONTACT: David Clugston (Portland) (503) 808-4751 Derek Fryer (Walla Walla) 509-527-7280

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: ADS-04-01

TITLE: White Sturgeon Passage at Lower Columbia River Dams.

FISH PROGRAM FEATURE: O&M - CRFMP - System

BIOP MEASURE: This evaluation addresses FWP Measure 10.4A.2 – Determine the impacts of the hydrosystem on sturgeon.

Although the white sturgeon fishery below Bonneville Dam is one of the most productive in the world, populations in the upstream reservoirs are affected by a reduction in swift-water spawning habitats, rearing habitat, and limited upstream and downstream movements of both sturgeon and 2 of their major prey species. Beginning in the 1980s the *White Sturgeon Mitigation and Restoration in the Columbia and Snake Rivers* and *Assessing Genetic Variation Among Columbia River Basin White Sturgeon Populations* projects are working to protect and restore white sturgeon populations and to mitigate for effects of the hydropower system. Among the methods being used are habitat and population studies, harvest management, artificial propagation, and transplant of juvenile fish from below Bonneville to upstream reservoirs. Improving passage for sturgeon at dams is an important part of future actions needed to help restore and maintain white sturgeon populations.

OBJECTIVES:

1. Evaluate upstream and downstream passage of white sturgeon at FCRPS dams in the lower Columbia River. (PLACEHOLDER).
    A. Evaluate passage/movements of adults in the east ladder at The Dalles Dam. 2004 –2006.
    B. Evaluate route specific survival of and tailrace egress of acoustic and balloon tagged juvenile sturgeon at The Dalles Dam. 2006-2007.
2. Evaluate how different operations effect survival, passage, and spawning success of sturgeon in vicinity of dams. (PLACEHOLDER).
    A. Evaluate effects of short-term water level fluctuations below BON on survival of white sturgeon eggs and larvae. 2006-2008.
3. Assess the effects of operational changes for sturgeon on salmon and steelhead.

SCHEDULE: 2005-2008

NOTE: Areas of interest are the lower Columbia River dams.

CONTACT: David Clugston (503) 808-4751

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: ADS-02-16

TITLE: Evaluation of Marine Mammal Predation below Bonneville Dam

FISH PROGRAM FEATURE: O&M and CRFMP – Bonn Sea Lion exclusion.

UPA MEASURE: Hydro Sub strategy 1.4, p. 19; ESU Specific Action, Adult Fish Passage, p 44.

MANAGEMENT PURPOSE: Evaluate techniques to deter sea lion predation on migrating salmonids and lamprey in the near dam area.

SUMMARY: California sea lion numbers on the west coast have greatly increased since the 1972 Marine Mammal Protection Act (See http://www.nmfs.noaa.gov/pr/laws/MMPA/) became law and male sea lions have moved into the Columbia River system in increasing numbers over the past 10 years. Sea lions sighted in the tailrace of Bonneville dam have increased from a handful in 2000 to 100 different individuals in 2003 and 2004. Estimates of predation on the Spring Chinook run in the Bonneville tailrace rose from around half a percent in 2002 to 2% in 2004 and 4% in 2005. Sea lions have returned to the tailrace earlier each year from 2002 to 2004, arriving as early as February. Sea lions depart the tailrace in late May and early June to return to the breeding grounds in southern California and off Mexico and disperse northward in late August and September.

In 2004, a marked sea lion made the first brief excursion into the entrances at the Washington ladder and in 2005 traveled extensively in the fishways. Up to 6 different individual sea lions were seen in lower ladders in a single day in the spring of 2005. As a result of concerns that sea lions in the fishways could block or significantly delay passage of migrating endangered salmonids, including the reduced spring Chinook run, emergency efforts began to keep sea lions out of the ladders. These efforts included initiating harassment techniques in the ladders and tailrace , setting up an acoustic deterrent system in the WA ladder junction pool, and developing exclusion gates for entrances to keep sea lions out. All of these efforts are acceptable techniques under the MMPA to address nuisance sea lions and have been used elsewhere with little or no effects on salmonids.

Willamette Falls has been using barred gates over their underwater orifices to deter sea lions from entering their ladders for several years. There was no finding of negative impacts on fish passage related to the installation of these gates at Willamette Falls, in fact, the numbers of fish passing Willamette Falls have increased during those years. Acoustic deterrent arrays have also been used for years at Ballard Locks to successfully keep naïve sea lions from the dam area. The frequencies are well out of the hearing range of salmonids and they have been used extensively at coastal fishpens with no ill effects on salmonids.

Due to the growing concerns of the effects on migrating endangered salmonids from the increasing number of sea lions and the apparent decrease in spring Chinook runs, evaluations of the predation and numbers of sea lions in the tailrace need to resume along with investigations into other means to deter sea lions.

OBJECTIVES:

1. Determine seasonal timing and numbers of sea lions present at Bonneville Dam. (2002-2007).
2. Estimate sea lion consumption of adult salmonids at Bonneville Dam. (2002-2007).
3. Identify individual sea lions at Bonneville Dam, determine whether they return in subsequent years, and their haul out areas. (2002-2007).
4. Determine effectiveness of acoustic and other deterrents outside fish ladder entrances and/or other locations in the tailrace. (2005-2007).
5. Evaluate effects of exclusion gates on fish passage. (PLACEHOLDER for 2006 dependent of results in 2005).

SCHEDULE: 2002-2007

NOTE: Area of interest at Bonneville Dam is the tailrace boating restricted zone.

CONTACT: David Clugston (503) 808-4751

Northwestern Division – Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: BT-W-01-01

TITLE: Effects of the Operations Dworshak Dam and Reservoir on Bull Trout Distribution in the Reservoir and North Fork Clearwater River.

FISH PROGRAM FEATURE: O&M – Bull Trout - Dworshak Fish and Wildlife Project Authority

BIOP MEASURE: USFWS BiOp 2000, Reasonable and Prudent Measure 10.A.3. and Terms and Conditions 11.A.3.

MANAGEMENT PURPOSE: Determine how the operations of Dworshak Reservoir effect bull trout in order to develop possible alternatives to minimize those impacts.

SUMMARY: Construction of the Dworshak Reservoir isolated the sub population of North Fork Clearwater River bull trout from others in the Clearwater Basin. Little information was available on how this isolation and the operations of the Dworshak dam have affected this sub-population when this project began in 2001. The reservoir may have affected the temperature regime, altered the life cycle of the bull trout prey and changed the migration behavior and seasonal distribution of the bull trout. In addition, Dworshak dam operations have the potential to not only remove bull trout and their prey from the reservoir but also effect the environment downstream through cool water releases and higher dissolve gas levels. The affect of Dworshak operations on the health of the sub-population is unknown.

This project has been very productive and has discovered a great deal. Annual adult bull trout migrations from the reservoir to the upstream tributaries have been observed between May and August after the spawning periods they retuned back to the reservoir between September and December. Much of the upstream migrations is during the period when reservoir elevations is dropping 2 feet/day. Many adult bull trout reside in the forebay from January through May; although there has been high spill around 16,000 cfs the project has documented entrainment of one radio tagged bull trout (1.6%) through October 2004, while the population has grown from 1057 (95%CI +/-408) to 1587 (95%CI +/-448) in 2003 and to 1977 (95%CI +/-725) in 2004.

OBJECTIVES:
1. Complete reporting on research on distribution, migration, spawning and effects of Dworshak Reservoir operations initiated in 2002, continuing through 2005.

SCHEDULE: 2001-2006

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: BT-W-06-04

TITLE: Effects of Water Withdrawal from Dworshak Reservoir on Bull Trout Distribution.

FISH PROGRAM FEATURE: O&M

BIOP MEASURE: USFWS BiOp 2000, Reasonable and Prudent Measure 10.A.3. Terms and Conditions 11.A.3.

MANAGEMENT PURPOSE: Determine how flow augmentation from Dworshak Reservoir may effect seasonal movements or spawning of bull trout from sub-populations in tributaries of the Clearwater River or lower Snake River.

SUMMARY: Construction of the Dworshak Reservoir isolated the sub population of North Fork Clearwater River bull trout from others in the Clearwater Basin. Little information is available on how this isolation and the operations of the Dworshak dam have affected this sub-population and other subpopulations upstream from the dam. The operation of the reservoir may have affected genetic interchange, migration behavior and seasonal distribution of the bull trout throughout the basin. In addition, Dworshak dam operations have the potential to not only remove bull trout and their prey from the reservoir but also effect bull trout from other subpopulations upstream from the confluence of the North Fork and main Clearwater Rivers.

RESEARCH OBJECTIVES:
1. Determine the origin, distribution, and numbers of bull trout in the North Fork Clearwater River below Dworshak Dam, as well as the main stem of the Clearwater River down to its' confluence with the Snake River.
2. Determine if bull trout from tributaries of the lower Snake River, specifically the Grande Ronde and Imnaha rivers and Asotin Creek, are attracted to the Clearwater and the North Fork Clearwater Rivers as a result of flow augmentation from Dworshak Reservoir.

SCHEDULE: 2006-2008

CONTACT: Fred Higginbotham 509-527-7236

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: BT-W-05-06

TITLE: Monitor the use of the main stem Columbia and Snake Rivers by bull trout.

FISH PROGRAM FEATURE: O&M – Bull Trout

BIOP MEASURES: USFWS BiOp 2000, Reasonable and Prudent Measure 10.A.3. and Terms and Conditions 11.A.3.

MANAGEMENT PURPOSE: This information would be used to determine the need for potential operational or structural changes at the hydro projects to avoid adverse impacts to bull trout.

SUMMARY: There is significant regional concern regarding the effects of lower Snake River and McNary reservoir hydro operations upon bull trout populations in the Columbia Basin. Little is known of bull trout occurrence, numbers, distribution, timing, behavior, or their survival through the Federal Columbia River Power System (FCRPS).

The Tucannon and Walla Walla River basins provides habitat for a population of bull trout. Individual radio-tagged adults from these populations may enter the lower Snake River or Columbia River in McNary Dam reservoir. Determining the numbers and seasonal movements of bull trout from the Walla Walla River basin would help the Corps determine the origin of bull trout that pass McNary or John Day dams on the lower Columbia River, or Ice Harbor dam on the lower Snake River. This information would be used to determine the need for potential operational or structural changes at the hydro projects to avoid adverse impacts to bull trout.

RESEARCH OBJECTIVES:
1. Determine the numbers, age classes, and seasonal movements of bull trout that move between the Walla Walla River and the main stem of the Columbia River.
2. Determine the numbers, age classes, and seasonal movements of bull trout that move between the Tucannon River and the lower Snake River.

SCHEDULE: 2005-2008

CONTACT: Fred Higginbotham 509-527-7236

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: BT-W-05-1

TITLE: Bull Trout Use of Lower Snake River Reservoirs and the Effects of Operations of Hydroelectric Dams on their Movements.

FISH PROGRAM FEATURE: O&M – Bull Trout

BIOP MEASURES: USFWS 2000 Biological Opinion, Reasonable and Prudent Measures: 10.A.2 and 10.A.3. Terms and Conditions**:** 11.A.2 and 11.A.3.

MANAGEMENT PURPOSE: This information would be used to determine numbers of bull trout that pass a given dam and the impact the FCRPS may have on sub-populations in the lower Snake River basin.

SUMMARY: There is significant regional concern regarding the effects of lower Snake River and McNary reservoir hydro operations centric to salmon and steelhead upon bull trout populations in the Columbia Basin. Little is known of bull trout numbers, distribution, occurrence, timing, behavior, or their survival through the Federal Columbia River Power System (FCRPS).

Based on historical passage information and a summary of research that was compiled in early 2004, it appears that the highest occurrence of bull trout passage at a lower Snake River hydroelectric project takes place at Little Goose Dam. The largest number of bull trout observed passing Little Goose in one year has been 24 in 2001. These fish passed Little Goose through the juvenile fish facility and the adult ladder. Hence, they could originate from several streams including the Tucannon, Grand Ronde, Imnaha, or Salmon Rivers, or Asotin Creek. If all of these fish were tagged and released it would be virtually impossible to obtain statistically valid information from a sample size this small. The need for further studies involving bull trout passage routes, water quality and seasonal use should be reevaluated pending discussions with the Region, State Fish & Wildlife agencies, and the U.S. Fish and Wildlife Service.

RESEARCH OBJECTIVES:
1. Determine the origin, distribution and enumerate the abundance of bull trout entering and using the Lower Monumental and Little Goose and Lower Granite reservoirs. 2007

2. Evaluate the passage route(s) of bull trout that move through the lower Snake River hydro-projects, particularly Little Goose and Lower Granite dams. 2007.

3. Analyze potential operational or structural changes that could improve passage and survival at Little Goose and Lower Granite.

SCHEDULE: PLACEHOLDER (The need for this study is dependent on the findings of the PIT tag studies on the Walla Walla and Tucannon Rivers: BT-W-05-06.)

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: BT-W-03-01

TITLE: Investigate the Effects of Water Quality on Bull Trout Survival Near Hydro-projects and Fishways.

FISH PROGRAM FEATURE: O&M – Bull Trout

BIOP MEASURE: USFWS BiOp 2000, Reasonable and Prudent Measure 10.A.3.,Terms and Conditions11.A.3.

MANAGEMENT PURPOSE: Determine the effects on bull trout of TDGS and water temperature in the FCRPS.

SUMMARY: Development and operation of the Federal Columbia River Power System has changed thermal regimes and TDG saturation production and distribution in the Columbia and Snake River basin. An altered thermal regime in the main- stem Snake River and Clearwater River could change the movements and survival of bull trout. As a result bull trout could cue to move to refuge conditions in tributaries later in the summer at a time when flows are low and water temperatures become lethal. Indirect temperature effects related to timing and duration of cool water releases from Dworshak reservoir may cause extra and delayed mortality to bull trout juveniles and sub adults passing through the Clearwater River and lower Snake River dams and reservoirs. It may also affect year-round habitat downstream from Dworshak. Adult bull trout may encounter high river temperatures or supersaturated dissolved gasses en route to entrance into tributaries. High temperatures may reduce reproductive success, increase susceptibility to disease, accelerate loss of energy reserves, extend passage delay and elevate stress of adult bull trout. Not enough scientific evidence is available to accept a generalized assumption that %TDGS exposure above 110% to bull trout would be similar enough to salmon (USFWS BiOp, 2000). There are documented differences in response between salmon and steelhead (i.e., salmon and trout), therefore likely differences between salmon and char, especially considering differences in their body composition and habits of distribution. It is not known whether adult bull trout are able to avoid areas of high temperatures or supersaturated gasses or how these variables affect their reproductive success. However, it is unclear if bull trout use of the lower Snake and Columbia rivers is sufficient to justify these expensive investigations.

RESEARCH OBJECTIVES:

1. Evaluate the effects of critical water quality parameters on distribution of bull trout between McNary and Dworshak Dams.

SCHEDULE: PLACEHOLDER for future work. **(The need for this study is dependent on the findings of the PIT antenna studies on the Walla Walla and Tucannon Rivers.)**

CONTACT: Fred Higginbotham 509-527-7236

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: TSP-06-01

TITLE: Biological Index Testing of Snake and Columbia River Dam Turbines

FISH PROGRAM FEATURE: CRFMP – tSYS-Turbine Survival Program

UPA MEASURE: Hydrosystem Substrategy 1.1; Key Alternatives Under Development – Turbine survival Improvements for John Day Dam; Powerhouse Improvements for Ice Harbor Dam; Project Configuration RM&E – Turbine Studies; Hydrosystem Studies on Turbine Survival

MANAGEMENT PURPOSE: Optimize turbine operations at John Day and Ice Harbor dams to improve the survival of juvenile salmonids passing through turbines.

SUMMARY: Current turbine operating guidelines for turbine units at Snake and Columbia River dams call for operating turbines within ± 1.0% of peak efficiency during the juvenile fish passage season. While juvenile salmonid survival is assumed to be greatest within this peak efficiency ranges, additional survival benefits may be realized by operating turbines at an optimal, open geometry. An "open geometry" is described as the best possible alignment of stay vanes and wicket gates combined with optimum runner blade angle to produce the best quality of flow (lower turbulence and shear) through the turbine environment. By optimizing the quality of flow (reducing turbulence and shear) through the turbine environment, mechanical injuries and egress time out of the draft tube may be minimized to improve total turbine survival. At John Day Dam (JDA), turbines can be operated from ~11.0 kcfs up to ~ 21.0 kcfs and still be within the 1% peak efficiency range. Quality of flow through the turbine environment over such a large range of discharge levels at John Day may be quite variable. In 2005, 1:25 scale physical models of JDA and Ice Harbor (units 1-3) turbines will be interrogated to determine optimal operating points (discharge levels) that provide the best quality of flow through each turbine unit. Once these operating points are identified in the physical models, field-testing and validation will be pursued in 2006 to test the hypothesis that turbine survival improvements can realized by optimizing turbine operation expressed as:

$$H_O: \text{Injury/Survival}_{\text{operating point x}} = \text{Injury/Survival}_{\text{operating point y}}$$

$$H_A: \text{Injury/Survival}_{\text{operating point x}} \neq \text{Injury/Survival}_{\text{operating point y}}$$

A cooperative effort between the John Day Configuration and Turbine Survival Programs will be employed to evaluate the effects of operating a JDA turbine unit(s) at selected discharges on fish survival. This research summary addresses the need to evaluate direct mortality and injury that may be associated with JDA turbine operation at various discharges, while SPE-P-00-7, Juvenile Salmonid Survival Studies at John Day Dam will evaluate total turbine survival, total turbine + total tailrace survival, and tailrace egress at various discharges. In addition to evaluating the hypothesis stated above in 2006, an assessment is needed to determine if the pressure environment encountered during turbine passage is injurious to the swim bladders of juvenile salmonids (see TSP-05-1, Pressure Acclimation Investigations to Support Biological Index Testing). This assessment needs to be conducted with run of the river juvenile salmonids that are naturally depth acclimated, have passed the selected turbine, and then collected immediately upon exit of the draft tube for necropsy.

OBJECTIVES:

1. Evaluate and compare the direct mortality and injury of juvenile salmonids associated with passage through a single JDA turbine unit under 3 selected operating discharges (±3% at α=0.05).
2. Evaluate and compare the direct mortality and injury of juvenile salmonids associated with passage through a single IHR turbine unit under 3 selected operating discharges (±3% at α=0.05).
3. Evaluate swim bladder condition (necropsy required) of run of the river juvenile salmonids after turbine passage upon exit of the draft tube under 3 selected operating points at JDA

SCHEDULE: 2006

NOTE: To determine the specific turbine unit, operating points, and release location(s) for these studies physical model investigations of newly constructed turbine unit sectional models for JDA and IHR have been scheduled for summer, 2005.

CONTACT: Blaine Ebberts, 503 808-4763; Dan Feil, 509 527-7295

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: TSP-05-1

TITLE: Pressure Acclimation Investigations to Support Biological Index Testing

FISH PROGRAM FEATURE: CRFMP – tSYS-Turbine Survival Program

UPA MEASURE: Hydrosystem Substrategy 1.1; Key Alternatives Under Development – Turbine survival Improvements for The Dalles and John Day dams; Powerhouse Modernization for McNary Dam; Project Configuration RM&E – Turbine Studies; Hydrosystem Studies on Turbine Survival

MANAGEMENT PURPOSE: Investigate components of turbine mortality to identify structural and/or design modifications in turbine design that can be integrated into the turbine rehabilitation process.

SUMMARY: Estimates of turbine survival for juvenile salmonids passing Corps operated dams on the Snake and Columbia Rivers can vary widely. For example, turbine passage survival for yearling Chinook salmon at Bonneville Dam Powerhouse II has been estimated at approximately 95% while averaging 84% at John Day Dam. The mechanism for such differences in survival has been poorly described to date. Much of the mortality associated with turbine passage at Snake and Columbia River projects has been attributed to mechanical injury and/or disorientation and subsequent predation in the tailrace immediately following turbine passage, though data confirming these mechanisms are unclear. Recently, it has been suggested that a portion of the mortality component associated with turbine passage may be attributed to the pressure cycle juvenile salmonids experience during turbine passage. In 2004, pilot laboratory tests were conducted by subjecting juvenile Chinook salmon to a pressure cycle event similar to what would be experienced during turbine passage. Results from these tests indicated juvenile salmonids that were allowed to acclimate or achieve neutral buoyancy at depths of 15 and 30 feet exhibited a higher incidence of swim bladder rupture, internal injury, and mortality than individuals that were surface acclimated or neutrally buoyant at the surface. The internal injuries observed were presumed to be a result of the instantaneous drop in pressure to near vapor pressure, encountered just downstream of the turbine runner, causing the swim bladder to expand, and in some cases, rupture. Tests in 2004 were conducted with minimal sample sizes and were not conclusive. In 2005, more rigorous testing is underway with run of the river, yearling and subyearling Chinook salmon. Additionally, tests in 2005 are being conducted with both untagged fish and fish tagged with a radio-transmitter, since tagged fish could be more susceptible to the effects of extreme pressure decreases because of the need to compensate for the extra mass of the tag to maintain neutral buoyancy (increasing swim bladder volume). Work in 2006 will focus on further characterizing the effects of the simulated pressure cycle associated with turbine passage. In-turbine pressure profiles can vary from project to project and may correlate with differences in turbine survival of juvenile salmonids observed across projects. Pressure profile data describing the in-turbine pressure environment will be available for several different projects (Bonneville PHI and PHII, John Day, McNary, Ice Harbor, and Wanapum) in 2006. Laboratory tests exposing run of the river juvenile salmonids to simulated turbine passage pressure profiles representative of field pressure profile data are needed to determine if threshold levels in pressure nadirs exist. Furthermore, if 2005 test results indicate tagged fish are more susceptible to the effects of the pressure during turbine passage because of the extra mass they must compensate for, some tag-size range finding needs to be conducted to identify tag size/fish proportions that eliminate this bias.

OBJECTIVES:

1. Evaluate the response to pressure profiles representative of turbine passage at Bonneville, John Day, and Ice Harbor dams for juvenile salmonids acclimated to 10, 20, and 40 ft depths,.
    a. Determine pressure effects on yearling Chinook salmon.
    b. Determine pressure effects on subyearling Chinook salmon.
2. Evaluate the response to simulated turbine passage pressure cycling for juvenile salmonids tagged with various sizes of transmitters and acclimated to 10, 20, and 40 ft depths.
    a. Identify tag/fish weight ratio thresholds for yearling Chinook
    b. Identify tag/fish weight ratio thresholds for sub yearling Chinook

SCHEDULE: 2006

CONTACT: Blaine Ebberts, 503 808-4763; Dan Feil, 509 527-7295

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: AVS-P-05 1

TITLE: Evaluate Caspian Tern Management Measures Relative to Their Impact on Salmonid Smolts in the Columbia River Estuary

FISH PROGRAM FEATURE: Estuary Program, CRFMP – xESTU Avian predation.

BIOP MEASURE: UPA, Predation Strategy 1.1 Redistribute Caspian terns nesting on East Sand Island in the Columbia River estuary to habitats located outside of the Columbia River Basin.

MANAGEMENT PURPOSE: Determine the effectiveness of Caspian tern management measures implemented to reduce the level of avian predation on salmonid stocks in the Columbia River estuary. Also assess the impact that Caspian terns nesting on Brooks Island, San Francisco Bay, are having on juvenile salmonid outmigrants at that location and determine if the impact is of sufficient concern to consider modification of the FEIS proposal to redistribute Caspian terns to that location.

SUMMARY: Caspian terns (*Sterna caspia*) were first recorded nesting in the Columbia River estuary in 1984. Since then, their numbers have increased from approximately 1,000 breeding pairs to nearly 10,000 pairs in 2002, the largest known breeding colony for the species in the world (Shuford and Craig 2002, Collis et al. 2002a, Suryan et al. In press). From 2000 to 2003, Caspian terns nesting on East Sand Island consumed an average of 5.9 million juvenile salmonids annually (the yearly average 4.2 to 8.2 million), including ESA-listed salmonids (Collis et al. 2002a, 2002b, 2003a, and 2003b). Although the Caspian tern breeding population in the Columbia River estuary has remained fairly stable since 1998, the colony on East Sand Island is expected to increase in size in the near future due to the high production of fledglings in 2001, 2002, and 2003 (Collis et al. 2002a, 2003a, 2003b). These cohorts are likely to recruit into the East Sand Island breeding colony starting in the 2005/06 breeding season, because the average age of first reproduction is thought to be 4 years (Suryan et al. In press). Thus, predation on juvenile salmonids by Caspian terns in the Columbia River estuary may increase in the future as the tern colony on East Sand Island grows. Ocean conditions appear to be headed into a downturn, which is anticipated to adversely affect productivity throughout the food chain and may result in a stronger dependence by Caspian terns on juvenile salmonids for forage resources in the near future.

Estimates of the number of out-migrating juvenile salmonids consumed by Caspian terns nesting on East Sand Island in 2003 (ca. 4.2 million) and 2004 (ca. 3.5 million) were still substantial but reflected a continued reduction from levels observed in the estuary from 1997-2001. Preliminary observations by USGS/OSU researchers in 2005 indicate that the percentage of juvenile salmonids in the diet of Caspian terns is higher during the early stages of the tern breeding season than for the comparable timeframe in 2004. Thus, initial indications are that total consumption of juvenile salmonids in 2005 by Caspian terns will exceed that of 2004. Potentially, with an extended period of adverse ocean conditions, Caspian tern predation on juvenile salmonids could reach 46-47% of their diet composition as observed in 2000-2001 for the East Sand Island tern colony.

The Final Environmental Impact Statement for Caspian Tern Management to Reduce Predation of Juvenile Salmonids in the Columbia River Estuary (FEIS) presents habitat management measures to address redistribution of the Caspian tern population. Measures presented would result in the reduction of available nesting habitat on East Sand Island, coupled with development of alternative habitat elsewhere in the region. Given authority and appropriation in WRDA 2005, habitat management measures for the redistribution of Caspian terns from the Columbia River estuary could begin in FY06.

OBJECTIVES:

1. Research, monitor, and evaluate Caspian tern predation on salmonid smolts in the Columbia River estuary.
2. Research, monitor, and evaluate response of Caspian terns to management measures implemented to reduce the size of the breeding colony on East Sand Island to the level stated in the preferred objective stated in the FEIS.
3. Research, monitor, and evaluate Caspian tern predation on salmonid smolts in San Francisco Bay.

4. Research, monitor, and evaluate alternative sites developed with implementation of the EIS to determine success of any effort to redistribute Caspian terns to colonies outside the Columbia River estuary.
5. Research, monitor, and evaluate the response of the regional Caspian tern population to implementation of the EIS.

SCHEDULE: 2004-2008

CONTACT: Geoff Dorsey (503) 808-4769

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: AVS-06-*New*

TITLE: Evaluate Management Measures and Develop Baseline Information on Double-crested Cormorants Directed at Reducing the Impact of Their Predation on Salmonid Smolts in the Columbia River Estuary

FISH PROGRAM FEATURE: Estuary Program, CRFMP – xESTU Avian predation

BIOP MEASURE: UPA, Predation Strategy 1.2. Perform analysis of the double-crested cormorant population in the Columbia River, and evaluate and implement alternatives to manage the cormorant population.

MANAGEMENT PURPOSE: Determine the population level of double-crested cormorants in the Columbia River estuary and the level of their predation on salmonid stocks in the Columbia River estuary. Assess the methods available to manage double-crested cormorant habitat and/or population levels to reduce their level of predation on salmonid stocks in the Columbia River estuary. Establish the baseline information required prior to development of an EIS concerning management of this species.

BACKGROUND: The double-crested cormorant (*Phalacrocorax auritus*) colony on East Sand Island consisted of approximately 12,480 nesting pairs in 2004, the largest nesting colony for the species on the Pacific coast of North America. This colony was first noticed in 1989, when a total of 91 double-crested cormorant nests were counted on East Sand Island. Unlike the breeding population of Caspian terns in the Columbia River estuary, the breeding population of double-crested cormorants has roughly doubled since 1998. The size of the East Sand Island cormorant colony increased by 23% in 2003 and 17% in 2004. East Sand Island represents one of the few sites in the Western United States where this species is experiencing a population increase.

Estimates of the number of out-migrating juvenile salmonids consumed by double-crested cormorants in the Columbia River estuary during 2003 (ca. 4.8 million) were similar to or greater than estimates of the number of smolts consumed by Caspian terns nesting on East Sand Island in 2003 (ca. 4.2 million). For 2004, an estimated 6.4 million juvenile salmonids were consumed by double-crested cormorants compared to an estimate of 3.5 million for Caspian terns. The anticipated downturn in ocean productivity forecast for 2005 will likely result in more juvenile salmonids being consumed by this species than in 2003 and 2004.

An Environmental Impact Statement for double-crested cormorants to address a population reduction and/or redistribution of the Columbia River estuary population is required per the settlement agreement for Caspian terns. Baseline research to determine the geographic limits of the Western Region population of this species and their population level has been initiated. Further research efforts are required to establish baseline information on management measures to attract this species to other locations and to dissuade the species from nesting on East Sand Island at the present level. An evaluation of present and former colony locations, the population levels they supported and/or can support, and a determination of factors that resulted in their abandonment or reduced use is also necessary prior to production of an EIS.

OBJECTIVES:

1. Research, monitor, and evaluate double-crested cormorant predation on salmonid smolts in the Columbia River estuary.
2. Research, monitor, and evaluate potential management methods to limit the size of the double-crested cormorant colony on East Sand Island, including manipulation of nesting habitat, social attraction, and redistribution of a portion of the colony to alternative colony sites outside the Columbia River estuary.
3. Research, monitor, and evaluate the regional double-crested cormorant population to determine sub-species status, population trends (current and historical), geographic boundaries, colony locations (present and historical), productivity, and habitat characteristics of colonies to gather baseline information for preparation of an EIS to potentially redistribute part of the East Sand Island colony to sites outside the Columbia River estuary, and thereby reduce predation on juvenile salmonids from the Columbia River basin.

SCHEDULE: 2004-2008

CONTACT: Geoff Dorsey (503) 808-4769

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: AVS-W-03-01

TITLE: Evaluate the Impact of Avian Predation on Salmonid Smolts from the Columbia and Snake Rivers

FISH PROGRAM FEATURE: CRFMP - tSYS PIT tag recovery-estuary & avian isl. (the avian and pair trawl will be separate items beginning FY06). Obj. 3 – O&M

UPA MEASURE: Predator Control Sub-strategy 1.3, p.23; Predator Control Actions, p.55

MANAGEMENT PURPOSE: Determine the level of avian predation on salmonid stocks from the Snake and Columbia rivers that pass through the McNary Pool.

SUMMARY: Caspian terns nesting on Crescent Island in 2000 and 2001 consumed an estimated 465,000 and 679,000 juvenile salmonids, respectively (Antolos 2003; Antolos et al. in prep). Non-transported steelhead are particularly vulnerable to tern predation at Crescent Island especially during low flow years. A minimum of 12.4% of in-river migrating PIT-tagged smolts from the threatened Snake River Steelhead ESU fell prey to Caspian terns nesting on Crescent Island in 2001 (Antolos et al., in prep.). Tern predation rates on the Mid-Columbia River Steelhead ESU (threatened) and the Upper Columbia River Steelhead ESU (endangered) are apparently similar. Increasing numbers of double-crested cormorants, California gulls, and American white pelicans are nesting on islands in the mid-Columbia River and little is known concerning the impacts of these colonies on survival of juvenile salmonids. Studies are needed to determine the magnitude and dynamics of predation on juvenile salmonids by piscivorous birds nesting in McNary Pool. These bird populations may pose an increasing threat to salmonid recovery because (1) the distribution, number, and size of bird colonies have been increasing throughout Eastern Washington and Oregon, and (2) current and future management of piscivorous water birds in the Columbia River estuary, and the Columbia Basin generally, may result in large numbers of these birds relocating to colonies along the mid-Columbia River.

OBJECTIVES:

1. Determine stock specific Crescent Island Caspian tern predation rates on salmonids based on PIT tag recoveries, bio-energetic modeling, and deposition rates, and determine factors influencing smolt vulnerability and consumption rates. (2004-2007).

2. Monitor and document colony size and formation of new colonies, determine habitat use, nesting success and factors limiting nesting success, and determine diet composition and consumption of juvenile salmonids for Caspian terns (focus on Crescent Island), double-crested cormorants (focus on Foundation Island), American white pelican (focus on Badger Island). (2004-2007).

3. Evaluate the necessity of the lethal removal of avian predators within the vicinity of Lower Columbia and Snake River COE dams as part of an avian predation deterrent program. (2005-?).

4. Assessment of the extent of potential salmonid predation by American white pelicans in the pool and tailrace of McNary Dam. (2003)

SCHEDULE: Work is ongoing, 2004-2007.

CONTACT: Scott Dunmire 509-527-7238

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: TPE-W-05-New

TITLE: Evaluate the effects of raceway and barge holding practices on SARs of juvenile salmonids collected and transported from Lower Snake River dams

FISH PROGRAM FEATURE: O&M-System-Transportation and CRFMP – Delayed Mortality

UPA MEASURE: Hydrosystem Strategy 3.2 and 3.3, p.21;

MANAGEMENT PURPOSE: Determine if density and species composition in raceways and barges is important for the survival of transported fish to increase the benefit of transport by potentially decreasing "D".

SUMMARY: Fish condition and physiology are known to play an important role in the survival of emigrating juvenile salmonids. Fish collected in bypass facilities and held at high densities, or Chinook with steelhead have been shown to have increased stress indices. Stressed fish may have decreased long-term survival. Studies are needed to determine if there is better density and/or species composition to hold fish in raceways and in barge holds that could yield higher SARs for transported fish. This information could assist in developing designs for a new juvenile fish facility at Lower Granite, additional barges, larger barges, increased barging frequencies, species separation, and increasing the number of raceways and capacities.

OBJECTIVES:

1. Historical analysis of PIT tag data for transportation of fish at Lower Granite, Little Goose, Lower Monumental, and McNary Dams. (2005).

2. Determine SARs for juvenile salmonids held at known densities in raceways and barge holds loaded from Lower Granite Dam and SARs for juvenile salmonids held at known species composition in raceways and barge holds. Test for significant difference (2006).

3. Pending results from objectives 2 and 3, determine if there is a better density and species composition to hold and transport juvenile salmonids in raceways and barge holds that produce the greatest SARs (2007 - 2008).

SCHEDULE: (2006 - 2008)

CONTACT: Scott Dunmire 509-527-7238

Northwestern Division – Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
STUDY SUMMARY

STUDY CODE: TPE-W-06-02 [formerly TPE-W-00-2]

TITLE: Alternate Barging Strategies to Improve Survival of Transported Juvenile Salmonids

FISH PROGRAM FEATURE: CRFMP – tSYS Delayed Mortality of Juvenile Salmonids
O&M - Transportation

UPA for BIOP REMAND: Hydrosystem Substrategy 3.3, p. 21. Juvenile Fish Transport Actions to Improve Fish Survival

MANAGEMENT PURPOSE: Determine if altering the barge release location is important for the survival of transported fish and help to decrease "D" and increase the benefits of transportation.

PROJECT INFORMATION: Previous work (1992-1994) examined an alternate release site at Tongue Point with a control release at Skamania Light using steelhead smolts. Adult returns were similar from releases at both locations except for the 1994 release when more adults returned from the Tongue Point release. Shreck et al (in prep) recommended utilizing the additional variables of darkness and peak outgoing tide along with an alternate release site to improve survival of Chinook salmon. In 2005, a study was initiated to investigate if a different release strategy of transported fish would improve survival of steelhead smolts. During the initial year, only juvenile fish survival between the existing barge release site and an alternate site at Astoria were investigated. Smolts were tagged with both PIT and microacoustic tags, and sampled for fish disease. The alternate release location utilized a release time coincident with the daily peak high tide during nighttime hours. The release timing was intended to minimize the opportunity for smolts to hold within the freshwater environment prior to saltwater entry. This strategy is thought to minimize predation risk and move juvenile fish out of the river into an environment with greater foraging potential to promote enhanced growth and survival. The river can be particularly adverse for smolt survival in low water years due to poorer water quality and the reduced water quantity. The long term objective is to improve Survival to Adult Return (SAR) of transported fish to be comparable or better than those that travel downstream inriver.

OBJECTIVES:

1. Determine survival differences through estuary for two release locations and tidal cycle for barged steelhead and spring Chinook. Confirm fish condition by examining the correlation with severity of infection with BKD (2005-2006)
2. Determine if Survival to Adult Return (SAR) is enhanced for steelhead and spring Chinook which have been transported downriver farther to an alternate release site over those released at the current site. (2006-2008) Determine if long term survival changes temporally within the spring migration season by utilizing an alternate release location.
3. Evaluate if juvenile survival through the estuary is correlated with rate of SAR. (2008-2009)
4. Evaluate if possible whether the type of water year plays a role in the effectiveness of using an alternate release location. (long term placeholder)

SCHEDULE: FY05-09

CONTACT: Ann Setter 509-527-7591

Northwestern Division – Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: TPE–W–04–02

TITLE: Evaluate the effectiveness of transporting Spring/Summer Chinook Salmon and Steelhead at McNary Dam.

FISH PROGRAM FEATURE: O&M-System-Transportation; CG-CRFM- Delayed Mortality of Juvenile Salmon

UPA MEASURE: Hydro Substrategy 3.3, p21-22; ESU Specific Actions, Juvenile Fish Transportation Operations RM&E, p52.

Management Purpose: Should juvenile spring/summer chinook salmon and steelhead be transported from McNary Dam or returned to migrate in-river via primary bypass?

BACKGROUND: Transport of spring migrants from McNary was suspended in the 1995 FCRPS Biological Opinion because a review of the data indicated the benefit from transport was uncertain. However, with the newer McNary Juvenile Bypass System, additional improvements to that system, and adult detectors at numerous ladders throughout the system, evaluation of transportation from McNary Dam is more feasible. It is also needed to provide information to make management decisions on whether or not to transport spring migrants from McNary Dam. The major operational alternatives following collection are transportation, primary bypass, and facility bypass.

OBJECTIVES:
1. Compare the SARs of transported, primary bypassed and non-detected passage routes at McNary Dam for hatchery spring/summer Chinook salmon and steelhead. Research results should include analysis of variables meant to lead to management decisions including but not limited to; the seasonality of transport benefits, effect of river environment, project operations, and the ocean environment.

   a. Test for a significant difference in annual and seasonal SARs of PIT-tagged hatchery spring/summer Chinook salmon and steelhead. Tagging at the hatcheries is completed; awaiting adult returns (2000-2008).

2. Test for a significant difference in seasonal SARs for the run-at-large including composite stocks of spring Chinook and hatchery Steelhead. Tagging would be expected to occur at McNary Dam (Pending results of 1a. above).

3. Estimate the seasonal differential delayed Mortality "D" of transported Chinook and Steelhead compared to non-detected in-river fish passing McNary Dam.

4. Compare the length at tagging to the length of fish passing Bonneville Dam with the SARs of returning adults.

SCHEDULE: 2001-2007 (Includes adult returns)

CONTACT: Derek Fryer 509-527-7280

NOTE: At a Walla Walla FFDRWG meeting, April 2003, the management agencies concurred that if transport of mid-Columbia stocks shows a benefit, it would be acceptable to transport Snake River stocks from this location as well without further evaluation.

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: TPE–W–04–03

TITLE: Evaluate the effectiveness of transporting sub-yearling Fall Chinook Salmon at McNary Dam

FISH PROGRAM FEATURE: O&M-System-Transportation; CG-CRFMP– tsys – Delayed Mortality of Juvenile Salmonids

UPA MEASURE: Hydro Substrategy 3.3, p21; ESU Specific Actions, Juvenile Fish Transportation Operations RM&E, p52.

DECISION QUESTION: Should juvenile sub-yearling fall Chinook be transported from McNary Dam or returned to migrate in-river via primary bypass?

BACKGROUND: At McNary, juvenile fish transportation occurs in the summer months only; spring migrating fish are returned to migrate in-river. Recent construction of the newer McNary Juvenile Bypass System and additional improvements to that system warrants a study at that facility to determine if migrating ocean-type sub-yearling Fall Chinook Salmon should be returned to migrate in-river or be transported below Bonneville Dam. Tagging sub-yearling fall Chinook occurred at McNary in 2001 and 2002. However, tagging in 2001 ceased in early July; Mid-July through Early August is the time period when the majority of wild subyearlings are passing McNary. Tagging in 2002 continued through early August and captured the wild component of the run-at-large.
Moreover, the new full-flow bypass was not operational until the 2003 smolt out-migration.

OBJECTIVES:
1. Test for a significant difference in SARs of transported (precision to be determined at a SRWG meeting), primary bypassed and non-detected passage routes at McNary Dam for wild Hanford Reach sub-yearling fall Chinook salmon. Research results should include analysis of variables meant to lead to management decisions including but not limited to; the seasonality of transport benefits, effect of river environment, project operations, and the ocean environment.
    a. Evaluate the feasibility of PIT tagging sufficient numbers of fish to conduct a transportation evaluation at McNary Dam (2005).
    b. Estimate travel times and survival to McNary and John Day dams to determine the numbers of PIT-tagged fish needed to for a full-scale study can be estimated (2005).
    c. Compare the annual and seasonal SARs of PIT-tagged wild sub-yearling Hanford Reach Fall Chinook, depending on results from objective 1.a. and 1.b. above (2006-2012 including adult returns).
2. Test for a significant difference in the annual and seasonal SARs of PIT-tagged Mid-Columbia hatchery sub-yearling fall Chinook salmon transported vs. bypassed vs. undetected at McNary Dam. Tagging would be expected to occur at Mid-Columbia Hatcheries. (2006-2012 includes adult returns)
3. Test for a significant difference in the annual and seasonal SARs of PIT-tagged run-of-the-river sub-yearling fall Chinook salmon transported vs. bypassed vs. undetected at McNary Dam. Tagging would be expected to occur at McNary Dam. Tagging in 2006 and 2007 through mid-August would yield 3 full tagging years. 2006-2012 (Pending result of 1a above)
4. Estimate the seasonal differential delayed mortality of transported sub-yearling fall Chinook salmon compared to fish that migrate in-river.
5. Compare the length at tagging to the length of fish passing Bonneville Dam with the SARs of returning adults.
6. Conduct a scale analysis to develop criteria in order to differentiate hatchery from wild and Snake from Columbia River stocks of juvenile subyearling Chinook.

SCHEDULE: 2005-2012 (includes adult returns)

POC: Derek Fryer 509-527-7280

NOTE: At a Walla Walla FFDRWG meeting, April 2003, the management agencies concurred that if transport of mid-Columbia stocks shows a benefit, it would be acceptable to transport Snake River stocks from this location as well without further evaluation.

Northwestern Division – Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
STUDY SUMMARY

STUDY CODE: TPE-W-06-NEW

TITLE: Influence of water characteristics on fish condition of smolts that arrive at Lower Granite Dam

FISH PROGRAM FEATURE: CRFM – Delayed Mortality (SCT)

UPA for BIOP REMAND: Hydrosystem Substrategy 3.3: Juvenile Fish Transport Actions to Improve Fish Survival; Habitat Strategy 1: Tributary Habitat Protection and Improvement

MANAGEMENT PURPOSE: Determine if fish condition at the time of entry into the hydrosystem affects long term survival.

PROJECT INFORMATION: Juvenile smolt survival may be compromised by their inherent fish condition prior to arriving at Lower Granite Dam. This study would begin a process of defining juvenile fish condition from a new perspective. Previous research has focused on stress and hormones. The hormone work has been largely focused on osmoregulatory and stress enzymatic functionality and level at various capture locations along the migratory route. The recognition that stress can influence survival of a compromised living organism is well researched in a variety of species. For Snake River salmon and steelhead, the various human activities that may indirectly influence their overall fitness has not been fully explored. The water that flows down the Snake River today has very different characteristics than it did historically. The types and sources of pollutants have evolved and the human population that contributes toxic materials to runoff from the various watersheds has increased. Water use has been affected and the subsequent dilution of toxic substances is often reduced, precipitating the potential for greater affect on living organisms. The pesticide and nutrient loads that can influence biological processes may compromise juvenile salmonids to an extent that stress takes a greater toll on the population than if they were in prime health. Long term fish survival is likely some function of the inherent integrity of the fish (fish condition) and the broad characteristics of the water. If juvenile salmonids are reaching the hydrosystem to continue their downstream passage in an already compromised condition, their response to stress is likely more life threatening. The changed water characteristics may become manifest by stress eliciting a reduced resistance to the many disease organisms present in the river migration corridor. This affect may not be immediate, and hence more difficult to trace as an influencing factor. It may be that the immune response system of fish exposed to water with detrimental characteristics has been compromised.

OBJECTIVE:
1. Define the water characteristics present in Snake River water that may be detrimental to the functioning of normal biological processes in juvenile salmon.

SCHEDULE: Placeholder

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: TPE-W-00-06

TITLE: Analyze the Benefits of Transporting Lower Snake River Juvenile Fall Chinook Salmon

FISH PROGRAM FEATURE: O&M-System-Transportation, CRFMP-Delayed Mortality

UPA MEASURE: ESU Specific Action, Juvenile Fish Transportation Operations RM&E, p.52

MANAGEMENT PURPOSE: Determine the optimal management strategy for Snake River fall Chinook, given that these fish exhibit both a subyearling and yearling life history. This is expected to provide the necessary information to determine if fall Chinook should be managed using a summer spill program or if the Corps should continue to maximize transportation for summer migrants.

SUMMARY: The 2000 BiOp stated that summer transport should be reassessed and as soon as the BPA transmission modifications have been completed and a comparative summer spill vs. transport study should be conducted from the Snake River. Currently for Snake River fall Chinook salmon, transportation is maximized and is done by barge between June and August 15 and by truck until approximately October 31. The benefits attributed to fall Chinook transport have been based on historic data and little baseline information exists for fall Chinook with regards to transport returns, migration characteristics and inriver survival under current river operations. Recent studies have shown SR juvenile fall Chinook salmon exhibit two life histories: an *ocean type* (juveniles first-year winter in the ocean) and *reservoir type* (juveniles first-year winter in reservoirs and then enter the ocean as yearlings). The complex life history of Snake River fall Chinook salmon, along with the absence of year-round PIT tag interrogation at the dams, complicates the design for transportation evaluations. It is not known where, when or in what proportions fish over-winter in the reservoirs or their survival. The region is working towards determining if a long term comparative transport study using empirical methods is feasible, or if a biological model approach could provide the required information needed to make informed decisions on how to determine the best management strategy for Snake River fall Chinook. A comparative transport vs. inriver spill vs. bypass passage study would require summer spill at all projects (collector and non collector). Before a summer transport/spill study begins in whole, optimal summer spill operations needs to be established.

OBJECTIVES:

NOTE: A regional Snake River fall Chinook subgroup is working collaboratively to develop long-term Snake River fall Chinook objectives. It is anticipated research objectives are to be developed by the end of June at which time a SRWG fall Chinook meeting is planned to address specific research questions.

SCHEDULE:

CONTACT: Scott Dunmire 509-527-7238

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
STUDY SUMMARY

STUDY CODE: EST-02-01

TITLE: A Study to Estimate Salmonid Survival Through The Columbia River Estuary Using Acoustic Tags

FISH PROGRAM FEATURE: CRFMP – Estuary Program

BIOP/UPA MEASURE: Reasonable and Prudent Alternative (RPA) 195 of the NMFS 2000 FCRPS BiOp required the Corps to "evaluate survival of fish passing through the FCRPS below Bonneville dam, which will include the estuary". This program began in 2001 in part due to this RPA. The 2004 Updated Proposed Action (UPA) addressing the NMFS CRFPS 2004 BiOp states that "All ESU's pass through the estuary and utilizes it to some extent. Therefore, the estuary habitat actions are listed here as benefiting all ESU's rather than listed ESU".

MANAGEMENT PURPOSE: The management implications are wide-ranging: (1) the actual survival of ESA listed salmon in the lower 146 miles is unknown; (2) survival through this reach may differ for fish with different passage histories through the FCRPS, (3) "delayed mortality" may be realized and studied in this stretch of the river, and (4) effects/impacts of the transportation program could also be evaluated within this program. Additionally, in 2005 this program has assisted the Operation and Maintenance program in obtaining much needed and potentially cost savings early in-water work scheduling.

GOAL: The Columbia River estuary is an important transition habitat to out migrating juvenile salmon, and the Corps has requirements to evaluate survival and habitat restoration actions. Recent evidence suggests that improvement in survival of the estuarine and early ocean life history phase of Columbia River salmon may be critical to the recovery of endangered stocks. Survival success of Columbia River salmon hinges on the complex interaction of smolt quality and the abiotic and biotic ocean conditions at the time of entry and during their first year of ocean residence. Factors that potentially affect age-class recruitment during the first months of ocean residency include fish size and health status at the time of entry, entry timing, and ocean conditions during the first months. These factors are influenced or controlled by several aspects of the Columbia River estuary: differences in life history strategies, river flow (hydropower system management), and estuarine habitat availability and quality. Therefore, it is important to understand how salmonids use the estuary, both spatially and temporally, and how different ESU's, life history types, and various rearing, passage, and condition histories use and benefit from the estuary, and how these conditions affect ocean entry and survival. Development of micro-acoustic transmitters will enable their use in the estuary environment for both ocean- and stream-type salmon. This will allow the following hypotheses to be evaluated a) interannual, life history (ocean- and stream-type), and biological (size/age) differences impact estuarine habitat selection and residence time, b) residence may vary within season, c) estuarine habitat use is patchy, not uniform, and salmonids key on specific habitat features, d) different passage route (bypass, transport, unknown) effect system mortality, and e) delayed mortality is exhibited during the lower river/estuarine residence/transit. Spatial and temporal observations of fish utilization of the estuary habitat are needed that link back to the variables described above, to develop hydropower management scenarios that benefit survival, growth, and health of juvenile salmon in the Columbia River estuary and their entry into and survival in the near shore ocean environment. It will be imperative that this research be discussed thoroughly with regional fishery managers to outline and prioritize actions.

OBJECTIVES:

1. Using the single-release statistical model estimate survival from Bonneville dam to the mouth of the Columbia River for target groups of various ESU's, and rearing, transportation, and hydrosystem passage histories (2005-2008). Compare survival through the lower river and estuary for various target groups evaluated.
a. Estimate survival of run of the river yearling Chinook salmon from Bonneville dam to the Pacific Ocean.
b. Estimate survival of run of the river subyearling Chinook salmon from Bonneville dam to the Pacific Ocean.

2. Continue development an acoustic tag that is small enough to use in ocean-type juvenile salmonids70mm in length (or smaller). Research and development needs to continue in the following area(s):

a. Continue investigation of new battery and transducer technologies to support the continued downsizing engineering effort.

3. Continue development of acoustic telemetry technology to facilitate estuary habitat use mapping and monitoring of behaviors relative to these habitats to support estuary habitat restoration activities. Continue to integrate findings with results from other COE and BPA funded estuarine habitat studies to link habitat use behaviors to growth, benefits, and survival into the near shore marine environment.

4. If 2005 data indicates there is lower than expected survival from Bonneville through the estuary partition survival estimates into three reaches to identify the relative losses of yearling and subyearling salmon in these reaches.

5. Continue investigating the effects of microacoustic transmitters on small juvenile salmonids to determine retention capabilities and to assist in developing guidelines for size thresholds and study durations.

SCHEDULE: 2001 – 2008

CONTACT: Blaine Ebberts 503-808-4763

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
STUDY SUMMARY

STUDY CODE: EST-02-02

TITLE: Estuarine Habitat And Juvenile Salmon – Current And Historic Linkages In The Lower Columbia River And Estuary

FISH PROGRAM FEATURE: CRFMP - Estuary

BIOP/UPA MEASURE: Reasonable and Prudent Alternatives (RPAs) 160, 161, 196 of the NMFS 2000 FCRPS BiOp required the Corps to "develop and implement an estuary restoration program, fund a monitoring and research program, and develop an understanding of juvenile and adult salmon use of the Columbia River estuary". This program began in 2001 in part due to these RPAs. The 2004 Updated Proposed Action (UPA) addressing the NMFS CRFPS 2004 BiOp states that "All ESU's pass through the estuary and utilizes it to some extent. Therefore, the estuary habitat actions are listed here as benefiting all ESU's rather than listed ESU".RPAs."

MANAGEMENT PURPOSE: This project has multiple management purposes, (1) one of the original driving factors for this research was to provide baseline information on ESA listed salmon use of the lower river and estuary, (2) this research also supports other funded programs (BPA and NMFS) in providing samples for genetic and life history evaluations, (3) this program is evaluating different habitat type salmon usage to better evaluate benefits to ESA listed salmon, and (4) is expected to assist in the regional programs in habitat restoration efforts.

GOAL: Understanding how juvenile salmon use of the Columbia River estuary in regards to rearing is vital to understanding the factors that effect their survival. Little information is available on which habitats are important, why they are important, and how they are used and for how long. The goal of this research will be to provide information that can be used to answer these questions, and assist in future estuary restoration activities.

OBJECTIVES:

1) Continue monitoring on use of estuarine habitat by juvenile salmon. This effort needs to be re-evaluated from past year's efforts to insure additional mark/re-capture of juveniles to better determine habitat use and benefits gained from the different habitats.

2) Continue developing linkages between juvenile salmon and habitat attributes that determine juvenile salmon use and performance in estuarine habitats. The first year's focus has been on tidal and forested wetlands; however, it is necessary to evaluate all potential habitat types for use and ESU fitness.

3) Continue developing monitoring stations to continuously measure the physical oceanographic environment in support of the biological studies in the Columbia River estuary

5) Initiate studies to characterize the role of sediment input into the estuary as a factor affecting habitat creation and use and performance (growth) of juvenile salmon of estuarine habitat in the lower Columbia
River and estuary

6) Continue/complete the reconstruction of historic estuarine habitats from pre-development topographic surveys (T-Sheets) to produce a complete GIS coverage of the estuary (mouth to Bonneville dam) at a scale of 1:10,000. An established protocol for data transfer to GIS, including georeferencing, edge matching, digitizing, and attributing will be applied to all remaining T-Sheets

SCHEDULE: 2000-2008

CONTACT: Blaine Ebberts 503-808-4763

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
STUDY SUMMARY

STUDY CODE: EST-02-03

TITLE: Evaluation Of The Relationship Among Time Of Ocean Entry, Physical, And Biological Characteristics Of The Estuary And Plum Environment And Adult Return Rates.

FISH PROGRAM FEATURE: CRFMP-Estuary

BIOP/UPA MEASURE: RPA's 161, 196 of the NMFS 2000 FCRPS BiOp required the Corps to "develop and implement an estuary restoration program, fund a monitoring and research program, and develop an understanding of juvenile and adult salmon use of the Columbia River estuary". This program began in 2001 in part due to these RPAs. The 2004 Updated Proposed Action (UPA) addressing the NMFS CRFPS 2004 BiOp states that "All ESU's pass through the estuary and utilizes it to some extent. Therefore, the estuary habitat actions are listed here as benefiting all ESU's rather than listed ESU".RPAs."

MANAGEMENT PURPOSE: While this program has potential management purposes more suited to the hatchery, harvest, and transportation programs than specific estuarine studies, the Portland District feels this data coupled with outside funding (BPA and NMFS) of estuary and near shore/plume habitats biological and physical characteristics is too valuable and important NOT to continue for the cost.

GOAL: The goal of this study will be to examine the relationship among time of salmonid ocean entry, physical and biological characteristics of the Columbia River estuary and near shore plume environment, and smolt-to adult return rates (SARs) for yearling chinook and/or coho salmon.

OBJECTIVES:

1. Estimate smolt-to-adult-returns of serially released yearling chinook and/or coho salmon through the spring migration period.
2. Characterize variations in the physical and biological conditions in the Columbia River estuary and near shore ocean environment during this time period.
3. Determine the level of physiological development and disease status of smolts at release.
4. Correlate SARs with environmental conditions.
5. Identify potential indicators (biotic, abiotic, or a combination of both) of salmonid marine survival that could be used to improve management actions.

SCHEDULE: 2000-2006

CONTACT: Blaine Ebberts 503-808-4763

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North Pacific Division – Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: EST-02-04

TITLE: Evaluating Cumulative Ecosystem Response to Habitat Restoration Projects in the Lower Columbia River and Estuary

FISH PROGRAM FEATURE: CRFMP – Estuary

BIOP/UPA MEASURE: Habitat restoration actions in the lower Columbia River and estuary (LCRE) were included in the 2000 (Action 160) and 2004 Biological Opinions on FCRPS operations. The Action Agencies' Implementation Plan for the Updated Proposed Action (March 2005; p. 45) called for cumulative effects research.

BACKGROUND: The types of estuarine restoration being implemented in the LCRE by the Corps and others include activities to: (1) reconnect backwater channels, sloughs and oxbows and recover estuarine wetlands through dike removal and tide gate replacement; (2) reconnect upland drainages and freshwater inflow through removal of armored channels, culverts, diversions, and other channelizing structures; (3) remove intertidal fills and piling fields; (4) allow natural accumulation of large woody debris; (5) place dredged material; and, (6) remove armor from shorelines. Such ecological restoration requires that detrimental changes be reversed to a ***measurable degree***. However, existing data collection and analytical methods are insufficient to evaluate the cumulative benefits to the ecosystem or salmon populations.

MANAGEMENT PURPOSE: The management implications are wide-ranging: (1) Decision support for estuarine restoration project prioritization; (2) evaluation of the ecological performance of collective estuarine restoration actions; (3) methods and data for Corps authorities under various Water Resources Development Acts (Sections 206, 306, 536, 1135); (4) protocols to sample listed subyearling fish in estuarine wetlands; (5) database for assessment of relative benefit of investments in tributary versus estuarine wetland habitats; and (6) a collaborative approach for a multi-stakeholder environment.

GOAL: Develop and employ science-based methods to quantify cumulative effects on ecosystem function from salmonid habitat restoration in the LCRE.

PROGRESS: To date, this study has (1) identified minimum and "higher-order" indicators and designed a weight of evidence approach for cumulative effects evaluation; (2) summarized juvenile salmonid usage of LCRE habitats to support method development; (3) proposed draft standard monitoring protocols for cumulative effects assessment and broader monitoring needs; and (4) involved multiple stakeholders in a monitoring protocol review and testing process using field testing at restoration sites in the LCRE.

OBJECTIVES (FY06):

(1) Assess the results of 2005 field studies and protocol testing, and revise and reissue a final draft *Columbia River Estuary Habitat Restoration Monitoring Protocols*.
(2) Using empirical data from 2005 field studies, determine the appropriate subset of "higher-order metrics" and model for cumulative effects. Metrics will represent habitat processes and functions, including landscape indicators, as well as juvenile salmon growth and survival.
(3) Continue implementing field evaluations of cumulative effects of restoration projects using standard methods, sensors and remotely operated technologies to measure the effects on listed salmon through ecosystem response. Candidate sites: Grays River; Vera Slough; Tenasillahe and Welch islands.
(4) Develop an adaptive management framework, including data management and dissemination, to support decisions by the Corps and others regarding LCRE habitat restoration activities.

(5) Develop methods and plans for TDG measurements within the estuary (Bonneville to the river mouth) in littoral/shallow water habitats, including measurements of effects on biotic inhabitants.

SCHEDULE: 2004-2010

CONTACT: Blaine Ebberts 503-808-4763